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THE ARGENTINE-CHILE TRANSANDINE RAILWAY will probably soon be completed. In our issue of April 23, 1903, we noted very briefly the present extension of the line. During the past session of the Chilean Congress a bill was passed for the construction of the closing link on the line, from Los Andes, Chile, to the point where the continental divide will be crossed, at the Cumbre de Cordillera. The Argentine side of the line is completed practically up to the divide, to Puente del Inca. The pass over the Andes is 13,000 ft. above sea level, but the railway line will cross the mountains by tunnel at an elevation considerably below this. The action of the Chilean Congress places the authority to let the construction (and operation) of the line in the hands of the President of the republic. The work is to be let as a "concession," the contractor building the line as his own property. The government guarantees 5% interest for 20 years on a sum not to exceed $7,209,750. The republic reserves the right to buy the railway in a term of five years for a sum not greater than 10% in excess of the capital invested. The line is to be of meter gage. Fuller details may be found in a report by Consul R. E. Mansfield in "Advance Sheets of Consular Reports" for May 2, 1903. This line will be noteworthy as completing the first transcontinental line in South America.

THE METROPOLITAN DISTRICT RAILWAY of London, England, is having two experimental electric trains of the multiple unit type built with a view to "electrifying" its entire line. Each train is of seven cars, each 50 ft. long, seating 38 to 48 passengers; three cars in each train are motor cars, but only the front and rear motor cars will be fitted with the controlling apparatus. One train is being equipped with the Westinghouse electro-pneumatic multiple control system (recently noted in Engineering News), by the British Westinghouse Company, and the other with the well-known Sprague multiple-unit system by the British Thomson-Houston Co. A rather novel feature of the electrical system is the use of two third-rails, so that the track rails carry no current; one of the conductor rails is midway between the track rails, the other is outside the track, 16 ins. from the gage line.

REPORTS OF TYPHOID FEVER at South Bethlehem, Pa., appear to have been exaggerated. We have good authority for the statement that the number of cases among the students at Lehigh University is not above the normal, and that while there has been more of the disease in the town at large than is usual, there has not been an epidemic. The water supply shows ten times the normal number of bacteria, and among these is coli communis. The milk supply is also suspected.

A STEAM CAR for use on local or branch lines of ordinary railways has been designed by Mr. D. Drummond, Superintendent of Motive Power of the London & Southwestern Ry., England, and built at the company's shops. It is 50 ft. long over the steel channel frame, and has two trucks with 8 ft. wheelbase. In front (outside the cab) is the vertical boiler, with vertical and cross tubes. The cylinders are inclined and outside, 7 × 10 ins., and the connecting rods are attached to crank-pins on the front wheels, the cylinders being between the wheels. The power is said to be sufficient to give an acceleration of 30 miles an hour in 30 seconds. Next to the boiler is an enclosed cab and baggage compartment, behind which is a covered platform forming the entrance to the passenger compartments. The first-class compartment seats 10 passengers on longitudinal seats; the third-class seats 32 passengers in cross seats on each side of a central aisle. At the rear is another platform. The car is to be run on the branch line between Fratton and Havant, and if it proves successful others are to be built. It is thought that such cars might be used for the light traffic on suburban lines between the rush hours, the heavy traffic during those hours being handled by trains in the usual way. Several cars of this type have been tried in this country, but without success, as described at length in our issue of Feb. 6, 1902.

HYDRAULICKING MACADAM is a novel method of road building, said to have been successfully used in California, according to the "San Francisco Chronicle," from which the following is abstracted:

At Weaverville, in Trinity county, roadmakers have been making a macadamized highway on Oregon Mountain in a manner never before attempted, probably, in the world. The side of the mountain is covered with quartzite that has been broken up by nature in uniform cubes of from two to four inches square, just as though the quartzite had been run through an up-to-date rock crusher.

The pulverized road-making material has been hydraulicked down on the road, covering it to a depth of 2 ft. and a width of 12 ft. One hundred and forty boxes are laid from the banks to the road, and from these the boxes are laid along the inner bank, a swinging box at the end being so arranged that the quartzite is deposited just where it is wanted. Water under pressure is turned into the boxes from a running ditch. The work is done cheaply and the road is made as fine as a turnpike, and will endure forever. Four miles of the road will be thus macadamized without using a pick, shovel or cart.

We have become used to the filling of trestles by the California hydraulic process, but to deliver nature-crushed stone in sluice boxes upon a highway is without doubt the most novel of all novel road-making methods. It can only be excelled by depositing natural paving brick in a similar manner upon concrete similarly made. After all, there is nothing impracticable about this method of macadamizing, except perhaps the "general cussedness of stone," which usually refuses to exist in small "two to four-inch" cubes on the side of a mountain, near the proposed roadway.

A WATER METER which "electrocuted" itself was described by Mr. A. A. Knudson at the recent annual meeting of the American Electrochemical Society, as follows:

During an examination in a city for electrolysis of water pipe our attention was called by the Superintendent of Water-Works to several water meters which he believed had been ruined by electrolysis caused by railway currents. After making careful tests at locations where these meters had been in use, and not finding any signs of railway current, we had one of them taken apart for closer inspection. We found in the interior a brass valve arranged to move over iron slides, the slides being a part of the iron frame of the meter. Suspecting galvanic action, we made an effort to measure the voltage, and selecting a meter that was not so damaged as to entirely prevent its working, we connected the brass valve with an insulated wire leading it out through the discharge, thence to the millivoltmeter. Another wire from the iron casing was connected to the opposite pole of the instrument. We then turned on the water from a service tap and allowed the meter to work the same as in practice; the effect was instantly shown upon the millivoltmeter which registered from 0.004 to 0.008 volt; variations of the needle between the minimum and maximum were caused by the variation of contact between the brass valve and the iron guides, over the uneven surface; the water was slightly brackish. The iron case was positive to the brass valve; the interior iron parts were softened and broke away. The number of this meter was taken, and the records in the office of the Water Department examined to see how long it had been in use, which was found to be about 12 years; from this data we make the following deduction. A water meter or other like instrument constructed with dissimilar metals such as brass valves running upon iron guides in brackish water with an average difference of potential of 0.006 volt, will in 12 years be ruined by electrolysis due to galvanic action, and register inaccurately in a much shorter period. It is but proper to say that water meters of this construction have long since been changed by the manufacturer, and those now made by the same firm are differently constructed and are not liable to galvanic action in their working parts. Other instances of the use of dissimilar metals in various other constructions could be mentioned, such as in steam plants, but we assume that sufficient has been said to at least call attention to the evils which may result from the use of dissimilar metals in contact with liquids, wherever they may be placed.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred at South Norwalk, Conn., on the New York, New Haven & Hartford Ry., on May 2. A passenger train was standing at a station when a freight train on the adjoining track backed through a cross-over into the side of the train. The smoker of the passenger train was completely wrecked, and two of the passengers in it were killed.

AN UNUSUAL CAUSE FOR A COLLISION is alleged by the engineer of the train responsible for the butting collision on the Intercolonial Ry., at Windsor Jc., N. S., noted in our issue of April 16. A freight train ran past a siding where it was to have met an express passenger train, disregarding both orders and signals. The engineer of the freight declares that he was unconscious at the time. He had, a few moment's before, gone out on the running board to fix the whistle cord which had broken; as he worked, steam from the whistle or the safety-valve blew out against his head and badly burned his face, rendering him unconscious. It was in this condition, he says, that he ran past his siding and thereby produced the collision, which occurred before he regained his senses.

A TRAIN RAN INTO A CROWD of people at Detroit, Mich., on the evening of May 3, and killed some seven or eight persons. The tracks of the Grand Trunk Ry. and the Lake Shore & Michigan Southern Ry. run side by side along Dequindre St. A special excursion train on the latter line, eastbound, was due to stop at the crossing of Canfield St., to take on a large crowd of excursionists. As the train was seen approaching the crossing, hundreds of the excursionists ran out on the tracks, in spite of the fact that the crossing gates were down. At this time a westbound express train on the Grand Trunk Ry. came along and ran into the mass of people on the tracks, with the result stated. The engineer of the express train appears not to have been aware of the fact that another train was to stop at the crossing, and it is likely that the headlight of the other engine prevented him from seeing the crowd.

A GREAT ROCKSLIDE AT FRANK, ALBERTA, on April 29, killed at least 60 inhabitants of the town. Turtle Mountain, which is of limestone, appears to have been undermined at one place by Old Man River, to such an extent that thousands of tons of rock suddenly slid down into the valley, burying many of the houses under 150 ft. of stone and covering an area of ¾ × 1½ miles. Seventeen miners were entombed by the slide, but dug their way out. Frank is situated on the Crow's Nest Pass, a division of the Canadian Pacific Ry., a few miles east of the summit of the pass. Being in a mining district, it was at first reported that an explosion of dynamite or mine-gas had caused the disaster.

LAYING MASONRY IN FREEZING WEATHER is rendered possible, it is said, by a substance recently brought out in Germany. The substance is a liquid, which, when mixed with the water used in making up the mortar, enables the latter to set properly even in the coldest winter weather. It is claimed that mortar made with the addition of the new substance shows even slightly greater strength than mortar made up with water. The liquid, which is marketed under the name "Calcidum," is a solution of chlorite of calcium, and has a freezing point far below zero. It is said to give equally good results with cement as with lime mortar.

EDISON'S GOLD SEPARATOR is again receiving notice in the papers. It is announced that the placer gravel is to be excavated by steam shovels, passed through a series of screens and then into the separators. A separator consists of a hopper, a roller that feeds the gravel in a thin stream or blanket and a rotary blower that forces a blast of air against the falling stream of gravel, deflecting the lighter tailings, while the gold drops straight down onto a conveyor which leads presumably to the nearest savings bank. In so far as this general description indicates the character of the invention there is no novel feature; doubtless it is in the details of the device that we may look for the improvements. The main difficulty, it is said, has been to secure a blast that would blow with equal pressure at all points. Patent lawyers are reported to be at work drawing the specifications and claims. If they are as successful in delaying the issue of this patent as they were on the Edison kinetoscopic camera, we shall know what the claims are in about 15 years.

THE WATER POWER DEVELOPMENT AT CHAUDIERE FALLS, P. Q.

The Chaudière River enters the St. Lawrence from the south some three miles above the city of Quebec. It has its source in Lake Megantic near the Maine state line, 150 miles away. About four miles above its mouth, the river tumbles over a jagged precipice and forms the picturesque Chaudière Falls. There is here a total difference in level of almost 100 ft. between the upper and lower reaches of the river, and at minimum flow there is available about 5,000 HP. Within the past two years a hydraulic plant has been constructed to utilize this power, convert it into electric energy and transmit this to the towns and cities nearby for power and lighting use. The following is a description of the work, together with some notes of experience on the construction.

FIG. 1. VIEW OF CHAUDIERE FALLS FROM BELOW.

GENERAL DESCRIPTION.

A short distance above the edge of the fall a concrete dam about 20 ft. high and about 800 ft. long has been thrown across the stream, being founded on bedrock. At its east end it joins the bank by a concrete abutment with wing walls. Near its west end the dam contains a narrow sluiceway, and between this latter and the west bank of the river is built the forebay. The forebay extends some 150 ft. north of the line of the dam and averages about 100 ft. wide. At its extreme northern end it is closed by a bulkhead wall in which the penstock inlets are located. The eastern or river wall of the forebay is a dam similar in section to the main dam and carried up to the same level of crest; this length of dam will be referred to in the following as the "wing dam." The total length of the weir formed by the main and wing dams together is about 970 ft.

The forebay is bounded on the west by an earth embankment with concrete corewall, which runs south to a point a little above the line of the main dam and then turns west to meet the high ground of the river bank. The entrance to the forebay is closed by a stone-filled timber crib extending from the junction of the main and wing dams southwesterly to the salient angle in the embankment, where the latter turns to the west. The crib is 20 ft. high and has its bottom edge set 10 ft. below water level; it rests on a series of concrete piers carried up from the bottom of the forebay. This arrangement leaves nine openings about 10 ft. wide and 8 ft. high below the crib, through which openings must pass all water that enters the forebay. Thus, floating objects, ice, etc., are kept out of the forebay; to further this end the crib is set at an angle with the main dam and a floating boom continues the line of the crib across the sluiceway opening, so that floating objects are deflected toward the dam to pass over its crest.

The wing dam forming one edge of the forebay maintains a flow of water here even when the penstock inlets are closed, which is of importance in preventing accumulation of ice in the forebay or around the penstock gates.

At the extreme northern end of the wing dam a scour pipe passes through the dam, below the floor level of the forebay; this is provided to wash out any deposits of silt which may form around the bottom of the bulkhead.

The sluiceway just east of the forebay entrance is a passage cut through the dam 12 ft. wide, and with the top edge of its floor 10 ft. below the crest of the dam. It is fitted with stop logs set in vertical grooves formed in the concrete of its abutments on either side. Provision for stop logs is also made in the openings under the crib, so that the forebay may be completely closed off when necessary, and emptied through the scour pipe mentioned above. The gate frames at the penstock inlets are fitted for stop-logs to be placed in front of the gates, so that any one or all of the penstocks can be closed off independent of the gates, for instance in case of failure of the latter to work properly.

The top of both main and wing dams is arranged so that flashboards may be put in place at any time to raise the water level above the dam. The abutments at all points are carried to a level 10 ft. above the crest of the dam, which is calculated to give ample margin in case of the highest flood which may be expected in the Chaudière River.

Fig. 2 is a general plan of the work. Attention is called to a ravine which begins as a slight depression at about the location of the bulkhead, and extends thence northward. This ravine deepens gradually until it comes to a sharp drop in the middle of its length and continues from there northward to the gorge of the lower reach of the river. This deep northern half of the ravine formed a natural location for a tail race, and it was so utilized, the power house being set just at the foot of the steep drop referred to, and the penstocks leading from the bulkhead of the forebay in a straight line north along the ravine to the power house. The river breaks into rapids at the foot of the falls, but just above the mouth of the tail race, so that the full head of both falls and rapids is utilized. It may be here noted that before the construction of the hydraulic works this ravine formed a natural overflow spillway at high stages of the Chaudière, the water entering it at the present location of the forebay and flowing north over the steep bank through the tail race location to the lower reach of the river.

The generating machinery is divided into four units, each of 1,000 HP. capacity, and consisting of a double Francis turbine direct-coupled to an alternating-current generator. The turbines are fed by two penstocks, 8 ft. 3 ins. in diameter, each supplying two units. A third penstock of the same size is provided in addition, and it is intended that this shall supply a pulp mill planned to be built adjacent to the power house. A separate smaller penstock, 30 ins. in diameter, supplies water to two sets of exciter turbines direct-coupled to generators.

As at present installed, the machinery of the plant comprises only two main units and one exciter set, and only one penstock has been built.*

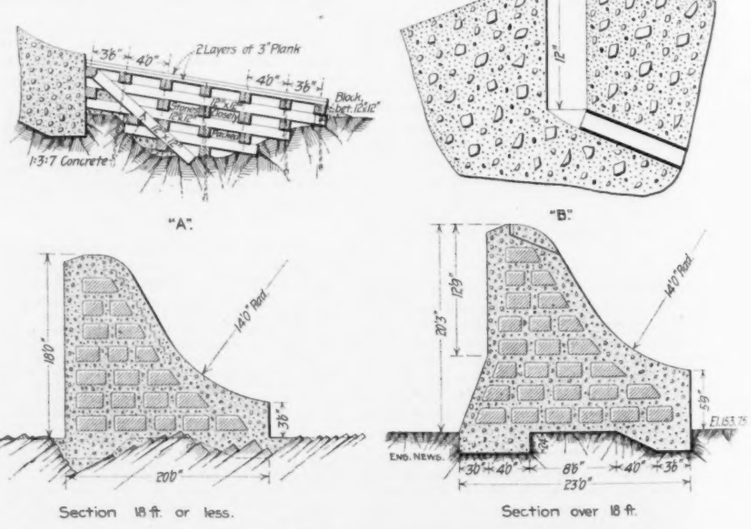


FIG. 3. SECTIONS OF MAIN AND WING DAMS.

which furnishes water to the exciter wheels as well as to the two main turbine units. The powerhouse structure, the tail race, and all the works at the upper level, have, however, been completed

*A second penstock is to be installed soon, supplying water to a turbine driving a 1,000-KW. generator; this generator is intended to be operated in parallel with the existing ones. It is proposed to provide this second penstock with a 100-ft. stand-pipe at the power house, to assist in regulating the turbines; the two penstocks would then be connected by a 78-in. pipe with gate valve.

for the full development. The inlet cones or entrance sections passing through the bulkhead for the other penstocks have also been set, together with the gates and mechanism, so that the remaining penstocks can be added and connected up without difficulty.

DETAILS OF CONSTRUCTION.

DAM.—The main dam across the river was originally designed to be of timber, but it was later decided to make it of concrete, with large stones imbedded in the mass.

The main dam varies from 16 to 22 ft. in height at different points, according to the irregularities of the river bed. Two sections of the dam are shown in Fig. 3 for heights under and over 18 ft.

The concrete in the dam is Portland cement concrete mixed in the proportion of 1:2:4. The imbedded stones were specified to be not closer to each other horizontally than 9 ins., and not closer vertically than 12 ins.; they were to be kept at least 20 ins. back from the face, or if the side of the stone had an area of over 4 sq. ft. they were to be no nearer to the face than 27 ins. The original design of the dam called for the downstream face to be built in 12-in. steps; when the actual body of the dam was thus completed the curved face was to be formed of these steps of 1:1½:3 Portland cement concrete, made with stone under 1 in. in size. The left-hand sketch in Fig. 3 shows in dotted lines the outline of this facing. The wing dam, which was the first section of the dam taken in hand, was commenced according to this plan; rough forms were used to mold the steps, and after the body had hardened the curved face was molded to templates carefully set to the curve. The body concrete was roughened with picks, and sprinkled with neat, dry, cement; then the facing concrete, mixed fairly wet, was tamped in place and its face worked smooth with a trowel, after which it was finished by sprinkling on dry cement and working this in with a smoothing iron. This method was abandoned, however, before the wing dam had progressed very far, and thereafter the whole of both main and wing dam was constructed entirely of the 1:2:4 rubble concrete molded at once to the curved outline of the face. The concrete was mixed quite wet, especially that next the forms on the curved face, so as to get a good, solid, surface without ramming hard enough to shake the forms out of shape. After the forms had been removed all loose stones were cleaned out and the face pointed up with 1:2 cement mortar; then this surface was drenched with water and sprinkled with dry cement, and the whole worked smooth. When the finish was dry a wash of thin cement grout was applied. This last wash coating was applied to all exposed faces of concrete throughout the work.

The bottom of the dam was designed to be notched into the rock, about as shown in the right-hand sketch, Fig. 3, or by the dotted lines in the left-hand sketch. On the main dam this construction could not be followed, on account of the dip of the rock foundation. The best that could be done was to shape the bottom as indicated by the full lines in the left-hand sketch, Fig. 3, taking out all loose pieces of rock until a sound bottom was obtained. To make up for the smaller resistance to sliding offered by such a base, the main dam was fastened to the rock with anchor-bolts, about one to every three feet of length of the dam. The bolts were of 1½-in. round iron with ends upset to 3 ins.; their length was 5 to 7½ ft., of which a little over half was in rock; they were set with cement in holes drilled in the final sound bottom. The wing dam, which is about at right angles to the main dam, runs across the outcropping edges of the rock strata instead of along them, and it was therefore possible to shape its bottom practically as called for by the drawings.

At the bottom of the downstream face of the dam the design provides for a timber apron extending some distance out from the dam, to prevent erosion due to the water falling over the dam. During the construction of the dam this apron was not at once built, since it was desired to hurry the concrete work as much as possible. As soon as the dam was put into service, however, it was found necessary to put the apron in place without delay, as the soft rock was being rapidly and deeply eroded by the water falling over the dam. In the sketch A, Fig. 3, is shown the construction of the apron at one of these deeply eroded portions of the river bed. On the upstream side a gravel talus was placed, with a slope of 1 on 1½, and reaching to about half the height of the dam.

The detail B, Fig. 3, shows the provision made for flashboards on the dam. Vertical holes 6½ × 4 ins. are cored in the top of the dam, 10 ins. deep, and studs for flashboards may be set in these holes when desired. An iron drain pipe leading from the bottom of the hole is embedded in the concrete of the dam.

BULKHEAD WALL.—The bulkhead wall at the north end of the forebay is also of concrete; its top is at elevation + 184, or 10 ft. above the crest of the dam. The penstock inlet cones are bedded in it, and steel framing set in the inner face of the wall forms supports for the gates and guides for stop-logs; a second steel frame set a few feet out from the first one supports the screen racks. Fig. 4 shows a plan of the bulkhead and its connection with the wing dam on the east and the embankment corewall on the west, and also a transverse section through the bulkhead. The steel framing is omitted in this figure for clearness; it is separately shown in Fig. 5. As will be seen here, vertical T-irons, 4 × 3½ ins., are set so that the edges of their webs form seats for the sliding gates, these edges being planed. The gate-sill is an I-beam with vertical web and planed top flange. The stop-log guides are vertical I-beams set just in front of the gate-frames and riveted to them.

In these views, Figs. 4 and 5, it will be noticed that the penstock inlets run only as far as 2 ft. from the inner face of the bulkhead. At this point, and also 8 ft. farther back, they are fitted with an angle-iron ring, which bonds them with the concrete and prevents seepage along their outer surface. The 2-ft. space to the inner face of the bulkhead is formed into an arched chamber

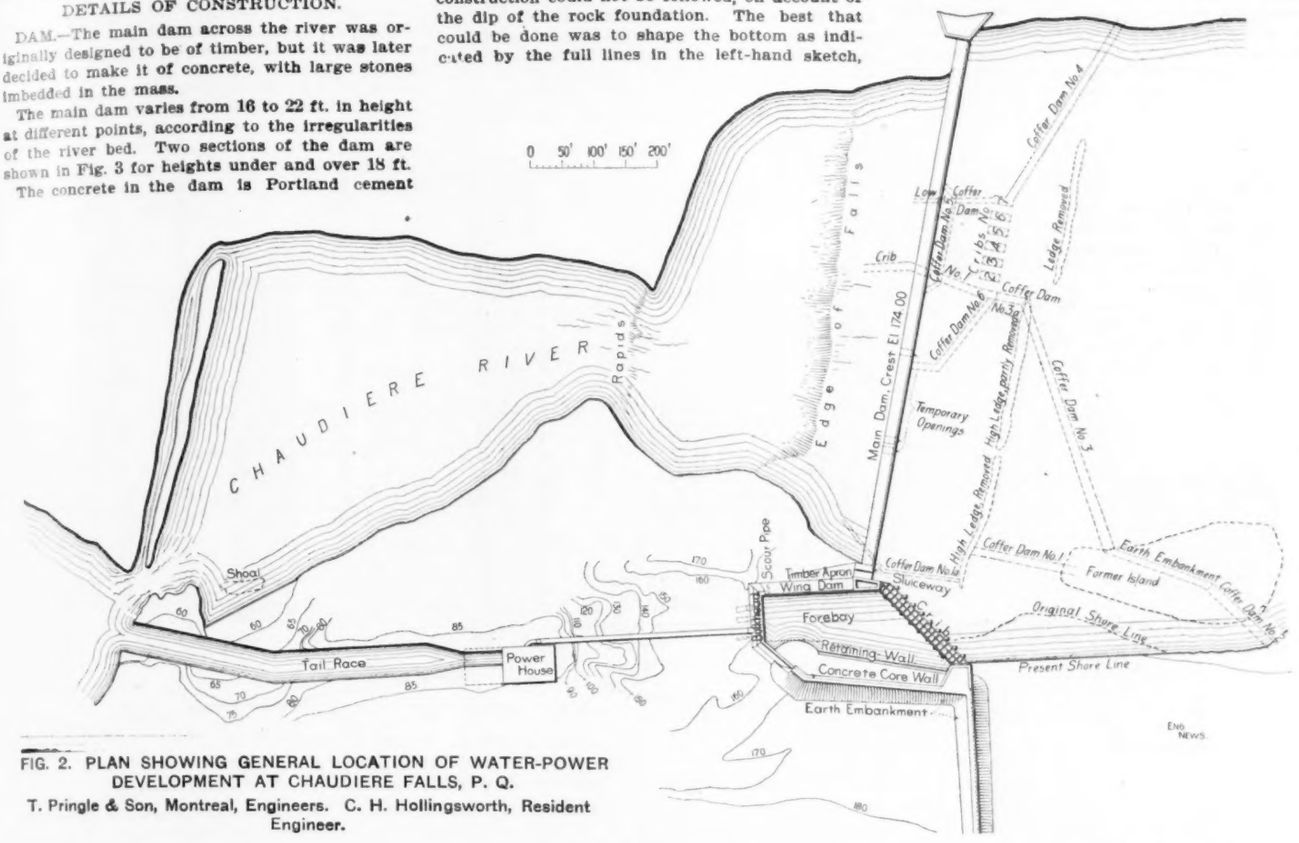


FIG. 2. PLAN SHOWING GENERAL LOCATION OF WATER-POWER DEVELOPMENT AT CHAUDIERE FALLS, P. Q.

T. Pringle & Son, Montreal, Engineers. C. H. Hollingsworth, Resident Engineer.

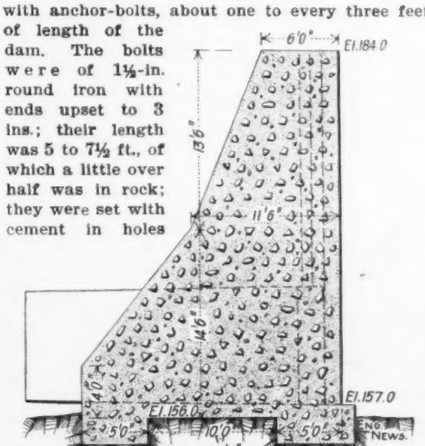


Fig. 4. Section of Bulkhead Wall.

of the same height as the inlets, and from this chamber several 10-in. vent-pipes lead to the top of the bulkhead.

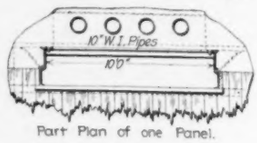
GATES.—The head gates are of special design; their construction is shown in Fig. 6, by a drawing of one of the large gates, 10 ft. wide and 9 ft. high. The gate is made of 8-in. I-beams running transversely, with a ⅝-in. plate riveted on the bulkhead side. Straps on the outside tie these together, while similar straps on the inside form the bearing faces against the I-slides of the frame. Cast separator brackets further stiffen the beams. The gate is divided horizontally 27 ins. below the top, and castings with planed horizontal joint-faces form the abutting joint between the two halves; similar castings are provided at top and bottom of the gate. The gate stem, 3½ ins. in diameter, runs through the upper section of the gate only, and is fastened to it by nuts. Two 2-in. bolts run vertically through both gate-sections; they are firmly secured to the lower section and have their nuts set 12 ins. above the top of the gate. Thus, when the gate is raised the upper section is first drawn up, leaving an opening 12 ins. wide by the full width of the gate, through which the penstock is filled. This relieves the pressure on the gate so that the whole gate can now be raised by means of the top section bearing against the nuts on the two vertical tie-rods of the gate.

The gate for the smaller penstock is in a single piece. The gate provided for the scour pipe (this pipe is shown in plan in Fig. 4) is also a single-piece gate.

Fig. 6 also shows the operating mechanism for the gates and a hoist arrangement for the stop-logs. The former, shown at A, consists of a simple set of gears mounted in a heavy frame; this frame is anchored strongly to the bulkhead concrete as it may be necessary to force the gates down against considerable pressure. For hoisting the stop-logs, which are 10 × 12-in. wooden beams 10 ft. long, the rigging shown at B is provided. The longitudinal angle shown serves for the support of a traveling carriage to which is fastened a tackle-block by means of which the stop-logs may be placed or removed.

EARTH EMBANKMENT.—The remaining portion of the works at the upper level comprises the crib at the forebay entrance, the sluiceway in the dam, and the earth embankment at the west of the forebay. The latter has a concrete corewall, 30 ins. wide at the bottom, and 18 ins. at the top, 3 ft. below the top of the embankment. The corewall was intended to be carried to solid rock, but this was impossible at some points; and here the wall was carried down into a good clay stratum and buttressed for additional safety up to the natural surface. The top of the embankment is at elevation + 186 and is 10 ft. wide; the outer slope is 1 on 2, the inner slope is 1 on 2½. The inner slope is paved with stone blocks. For the greater part of the length of the embankment it was found impracticable to continue its inner slope to the bottom of the forebay, and a rubble masonry retaining wall was therefore built, 20 ft. high at its highest point, to give the proper width to the forebay and yet maintain the original location and slope of the embankment.

SLUICEWAY AND ENTRANCE CRIB.—The construction of the crib and adjacent parts of the work is made clear by Fig. 7. The west end of the crib is supported on a concrete pier located at the angle in the earth embankment and forming a continuation of its corewall. The eastern cribseat is on a heavy abutment forming the termination of the wing dam and the west wall of the sluiceway. This abutment is braced in both directions by wing dam, main dam, and crib, and



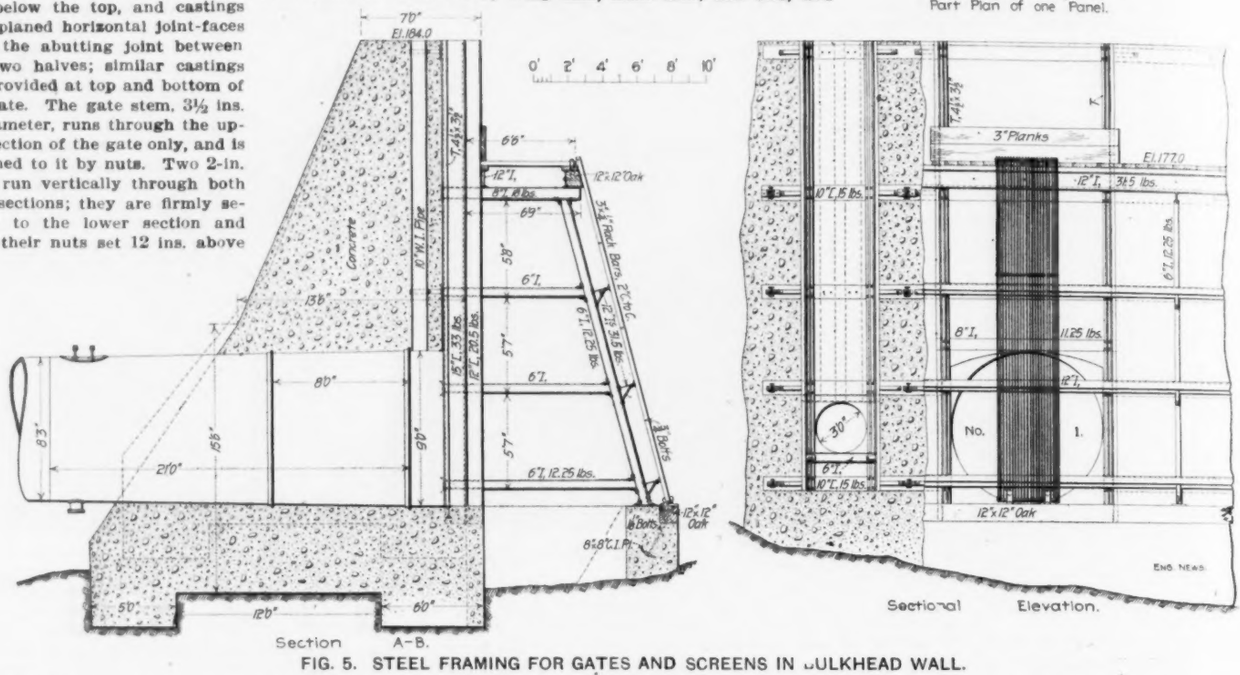


FIG. 5. STEEL FRAMING FOR GATES AND SCREENS IN BULKHEAD WALL.

for this reason it was thought permissible, for the sake of economizing on concrete, to make its upper part hollow and fill in with loose stones. The hollow space is clearly shown in Fig. 7; after the concrete had set the hole was filled with stones packed in place, and a 12-in. layer of concrete laid across the top. The sluiceway adjoining to the east will be readily understood from the drawing; it is 12 ft. wide and 30 ft. long, with a crest 10 ft. below the crest of the dam. The floor was covered with 6-in. plank to take the scour of the water. Vertical checks or grooves near the upstream end of the sluiceway are provided to receive 12-in. stop-logs.

The crib across the forebay entrance is a simple (pine) timber cribwork filled with loosely packed stones of all sizes available; its construction is sufficiently shown in Fig. 7. The crib is anchored to each of its abutments and intermediate piers by four 1½-in. anchor bolts. The piers are of concrete with embedded stones, and are faced with 2 × 4-in. timbers laid on flat and spiked together, braced across at frequent intervals by similar strips. The upstream face of the crib is sheathed with two layers of 3-in. plank set vertically. At the angle where the crib projects into the stream, at its eastern end, it is provided with a facing of ¼-in. iron plate extending 3 ft. each way from the corner, to protect it from drift and ice.

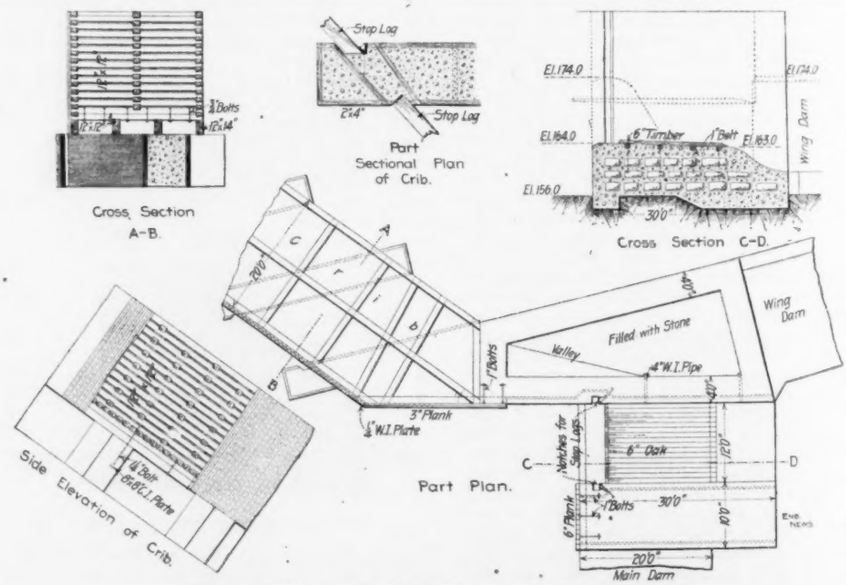


FIG. 7. DETAILS OF SLUICEWAY AND ENTRANCE CRIB.

PENSTOCKS.—The penstocks run north from the bulkhead almost level for about 160 ft., and then drop down over the bank on an angle of about 45°. The rock excavation for the inclined part of the penstock was quite awkward, as the strata of the rock, a red shale, were at right angles to the grade, and the blasting therefore produced a very irregular surface. The penstock consists of 5-16-in. and ⅜-in. plates, and is built in 5-ft. lengths. Every 15 ft. it is supported on light steel bents with a cradle angle fitting the bottom half of the pipe. The vertical legs of these bents are anchored in concrete piers set in the rock. The pipe on the slope is anchored at two points by pairs of 2-in. rods about 20 ft. long, running parallel to the pipe, and connected at their upper end to anchor bolts set 7 ft. in the rock, and at their lower end to angle-clips attached to the pipe near its lower quarter-points. These anchors, as well as one of the supporting bents, are shown in detail in Fig. 8.

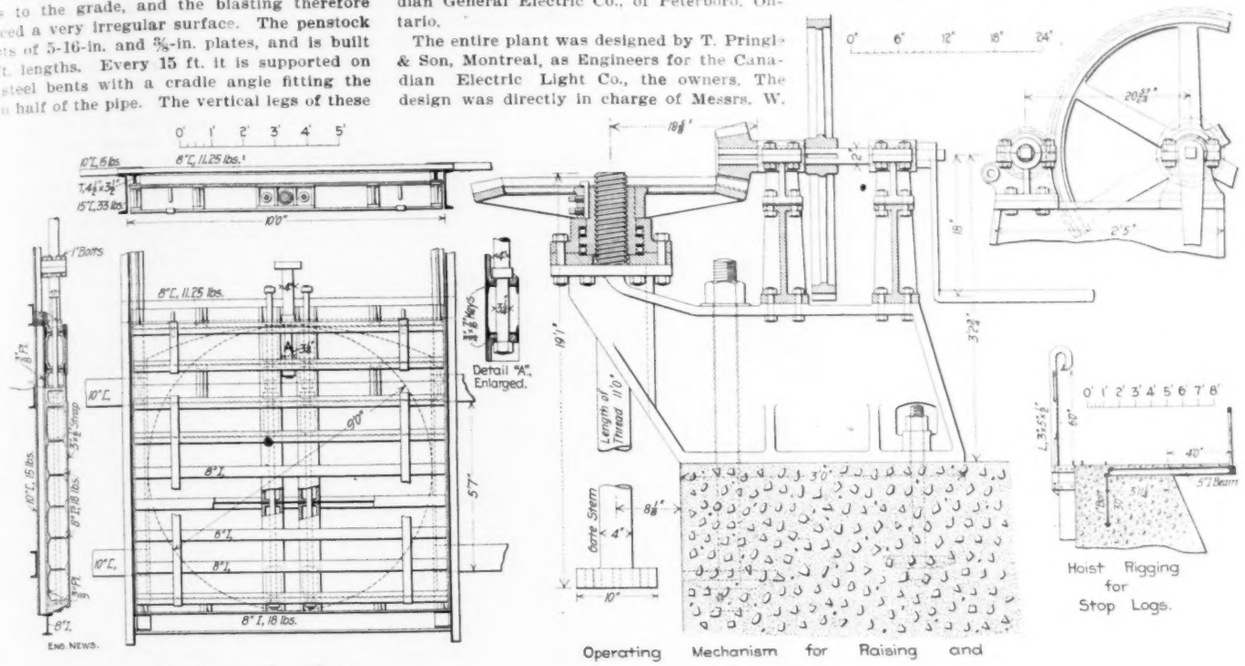

Details of Gate.
Operating Mechanism for Raising and Lowering Gates.
Hoist Rigging for Stop Logs.
Detail "A" Enlarged.
Length of Thread 11'0"
Eng. News.

FIG. 6. GATES, OPERATING MECHANISM AND HOIST RIGGING FOR STOP-LOGS.

POWER HOUSE.—The power house is simple in arrangement and presents few unusual features. A plan and a transverse section of the structure, showing location and arrangement of the machinery and equipment, are given in Fig. 9. Under the main turbine, along the east wall, a longitudinal tail-pit is excavated covered by an arched roof which supports the turbines. This pit opens directly into the tail race at the north end. The exciter wheels are placed along the south end of the power house, over a transverse tail-pit which communicates with the pit below the main wheels. The generators are set west of the turbines, over small pits which communicate by means of 9-in. tile ducts with the cable tunnel, running along the west wall of the power house. The switchboard is placed just in front of the cable tunnel.

In the outer side of the bend in the main penstock there are two Lombard relief-valves. In its lower horizontal section, where it branches to the different turbines, the penstock is anchored by three sets of anchors similar to those used on the slope.

The turbines were built by the S. Morgan Smith Co., of York, Pa. Each unit consists of two special 33-in. wheels, with cylinder gates, mounted on a horizontal shaft, and discharging inward and downward through a steel draft-tube 5 ft. 6 ins. in diameter at the top. The wheels run at a speed of 400 r. p. m. Under a head of 110 ft. each unit is capable of developing 1,400 HP. The wheels are controlled by Lombard Type B governors.

The two generators are revolving field alternators of 750 KW. capacity each, delivering current at a frequency of 66⅔ cycles under a pressure of 10,500 volts. The full-load efficiency of the generators is 94%, and they will stand a 25% overload for four hours without heating beyond the limits of modern practice. The two exciter dynamos are four-pole generators running at a speed of 1,050 r. p. m. Their capacity is 30 KW. each, furnishing current at 125 volts. The main generators, exciters, switchboard and all the electrical equipment, were supplied by the Canadian General Electric Co., of Peterboro, Ontario.

The entire plant was designed by T. Pringle & Son, Montreal, as Engineers for the Canadian Electric Light Co., the owners. The design was directly in charge of Messrs. W. I. Bishop and J. W. Thurso. All construction work was in charge of Mr. C. H. Hollingsworth, Resident Engineer, who made such changes in plans and specifications as were found necessary in the course of the execution of the work. The contractors were the Engineering Contract Co., of New York; Mr. J. McGovern was the superintendent in charge on the first part of the work, and Mr. H. Holgate on the remainder.

Work on the plant was begun Sept. 5, 1899, and the whole installation was completed and put into operation on April 5, 1901. The total cost was about $400,000, which sum includes also the cost of the electrical transmission line, about ten miles long, to Levis, P. Q. A view of Chaudière Falls from below after completion of the work is shown in Fig. 10.

In the following are summarized some notes on the work of construction, touching various matters of interest to the engineer. These notes were made by Mr. Hollingsworth, the Resident Engineer, to whom we are also indebted for the material from which the preceding description, text and illustrations were prepared.

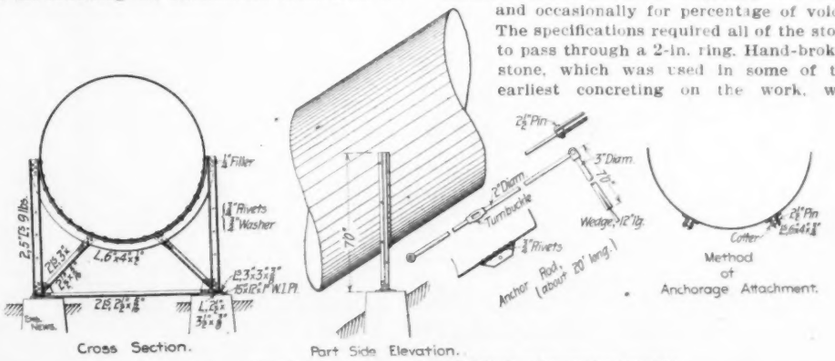


FIG. 8. SUPPORTS AND ANCHORAGES FOR PENSTOCKS.

CONSTRUCTION NOTES.

CEMENT AND CONCRETE.—As concrete played such a large part in the entire construction its make up and manipulation received much attention. A portion of the cement used was of Canadian manufacture, but the greater part was German Portland, the Hemmoor and Heidelberg brands being used. A test sample was taken from every lot of 100 bbls. or less; tests were made for fineness, specific gravity, soundness, constancy of volume and tensile strength. In making briquettes for the tensile test, the mold was filled and then a pressure of 20 lbs. per sq. in. applied for half to one minute. The requirements were, for neat cement 400 lbs. in 7 days and 500 lbs. in 28 days, for 1:3 mortar 145 and 225 lbs., respectively. A total of about 30,000 bbls. of cement was used on the work.

The sand obtainable was not very good; it was chiefly disintegrated shale, the grains being flat particles of the rock. The sand was very light in weight, and was coarser than desired; the specified test of 80% passing through a No. 20 screen, but retained on a No. 30, had to be modified to 60%, which was the best result obtainable. Sand tests were made twice a week. Occasional tests were made to determine the percentage of voids.

Broken stone was tested frequently for size, and occasionally for percentage of voids. The specifications required all of the stone to pass through a 2-in. ring. Hand-broken stone, which was used in some of the earliest concreting on the work, was found to be very uniform in size, and to run high in voids, often up to 50%. Stone broken by crusher with jaws 2 ins. apart would run 20 to 30% over 2 ins. in size and gave about 45% of voids; with jaws 1¼ ins. apart the stone ran 98 to 100% under 2 ins. with about 42% of voids. It was found that if the crushers were kept full all the time the product was much smaller, especially in the case of the Gates gyratory crusher which was used on part of the work.

Though a little more than rated power was required when the crusher was thus kept always full, this practice secured increased economy in both quantity and quality of product. Regarding hand broken stone, it was found early in the work that with such stone the voids were not completely filled in a 1:2:6 mixture, and therefore a 1:2:4 mixture had to be used, this being on the corewall of the embankment west of the forebay. Further, on making some crushing tests on 9-in. cubes of 1:2:4 concrete, which when made with machine-broken stone gave strengths after 28 days of from 1,800 to over 2,700 lbs. per sq. in., similar tests when hand-broken stone was used ran as low as 850 lbs. per sq. in.

The large stones imbedded in the concrete of the dam and abutments were obtained from the hard ledges in the river bed, and on account of the stratified and also seamy nature of the rock the stones came out in good shape for bedding well and regularly. In one part of the dam, where large and extra well-shaped stones were used, the relative amounts of concrete and stones placed were carefully measured, and it was found that the large stones made up as much as 40% of the volume of that part of the dam. On the average over the entire dam, however, it is estimated that the stones formed not more than 25 to 30% of the volume.

CONCRETE MIXERS.—Most of the concrete on the work was mixed by machine; both Drake and Cockburn mixers were used with good results. On part of the concrete work in the power house substructure a gravity mixer was used, but the results were very unsatisfactory. The mixer was a square chute of steel plates with small rods running across it and with a hopper-shaped top; the water was introduced through a perforated brass tube running across the chute near the top. The materials on being thrown into the hopper were supposed to thoroughly mix in their passage down the chute by being thrown from side to side by baffles on the sides of the chute, set at an angle of about 30° with its axis; the rods served to further intermingle the materials. The machine produced a very poor mixture even after the right inclination of the chute had been determined by much experimenting. It was found necessary to turn the dry mixture twice by hand before throwing into the hopper, and to turn the wet product twice after it came out of the chute; only in this way could a well-mixed concrete be obtained.

ADHESION OF CONCRETE TO ROCK.—In placing the concrete on new bottom in the river bed great care had to be exercised to get good adhesion between rock and concrete. After the gravel, etc., had been cleared off the rock, and the latter excavated to firm bottom (or rather as firm bottom as was obtainable at the location in question), it was carefuly gone over with water and brooms, and washed and scrubbed until entirely clean. Then a 2-in. layer of 1:2 cement mortar was laid on the bottom, on which layer the concreting was started.

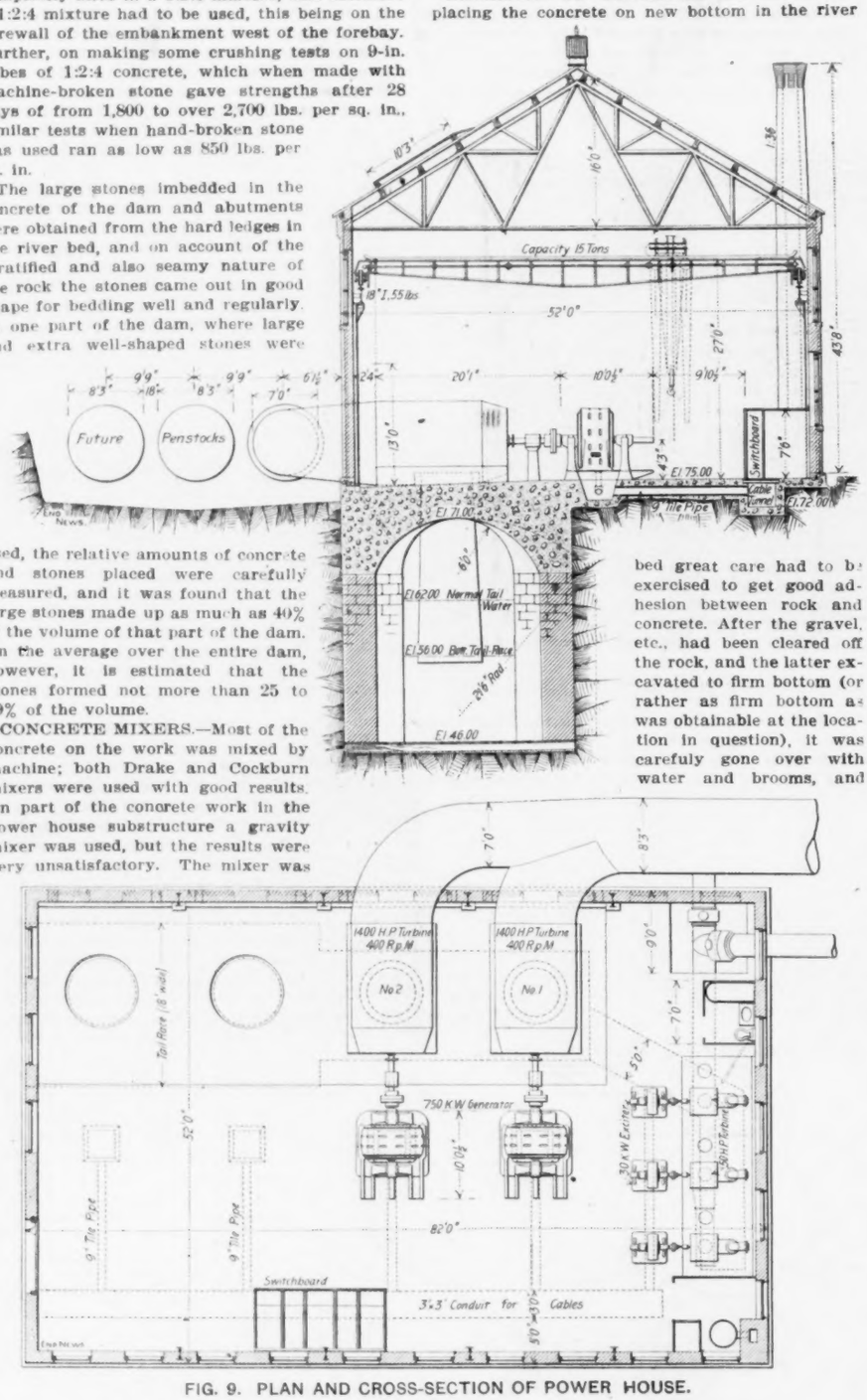


FIG. 9. PLAN AND CROSS-SECTION OF POWER HOUSE.

A chance experience furnished a good illustration of the necessity of thus carefully cleaning the rock bottom before beginning to lay concrete. Late in 1899 a batch of concrete of about three or four cubic yards was dumped to waste near the sluice way site, at a point where the loose rock had just been removed to sound bottom. During the winter this location was overflowed, but the next spring the site was laid dry and cleared, preparatory to putting in the sluiceway. The batch of concrete had spread out into a sheet less than a foot thick and had, of course, set firm and hard. However, as it sounded hollow it was removed, and was found not to have adhered to the rock: between rock and concrete there was a thin layer of mud, sawdust and leaves, and a thick coating of the same material covered to the top of the concrete. As it is certain that this material was not on the rock when the concrete was dumped there, it must be concluded that there was a little sand and other dirt on the rock at the time, and that this had prevented the concrete from adhering. The mud, leaves, etc., were washed in later when the river covered the site and the water penetrated into the crevice between concrete and rock. After this experience even greater care was taken to get a perfectly clean bottom before starting concreting on rock, and in addition to the regular inspector the engineer in charge in each case personally looked over the new bottom before concrete was laid.

CONCRETING IN FREEZING WEATHER.—The construction of the lower 8 ft. of the wing dam was interesting because it was carried on during the winter, when the temperature ranged all the way down to 20° below zero. The necessity for this arose as follows: By the end of 1899 the forebay embankment, the entrance crib, and the crib abutments had all been completed and some work had been done in the tail race. From the east the forebay was protected from the river by a rock ledge, which, however, was below highwater level. During the winter, when the river was high, the water would therefore be able to enter the forebay from the east, and flow down over the bulkhead site and out through the tail-race location. This would have caused great trouble and delay in resuming work in spring (and would have interfered with carrying on the tail race excavation through the winter) and it was therefore necessary to carry up the wing dam high enough to keep the river out of the forebay from the east at its highest stages. Since the wing dam was not started until late in December, this meant winter work in concreting, which was successfully carried on as follows:

The wing dam and its end piers aggregated about 250 ft. in length by about 20 ft. in width. A house 100 ft. long and 24 ft. wide was constructed in sections about 10 ft. square connected by cleats with bolts and nuts. This house was put up over the wing dam. It was 20 ft. high to the eaves, with a pitched roof, and the ends were closed up; in the roof on the forebay side were hatchways with sliding doors along the whole length. Small entrance doors for the workmen were provided in the ends of the building. The house was heated by a number of cylindrical sheet-iron stoves about 18-ins. in diameter by 24 ins. high, burning coke; thermometers placed at different points in the shed gave warning to stop work when the temperature fell below freezing, which, however, rarely occurred. Mixing boards were located in the shed, and concrete, sand, and broken store were supplied in skipfuls by guy derricks located in the forebay, which passed the material through the hatchways in the roof, the proper hatchway being opened for the purpose and quickly closed. The mortar was first mixed on a board, and then a skip-load was dumped into the middle of the batch and the whole well mixed. The water was made lukewarm by introducing a steam-jet into several casks which were kept full. The sand was heated outside in the forebay on an ordinary sand heater. The broken stone was heated in piles by a steam-jet; a pipe line on the ground was made up of short lengths of straight pipe alternating with T-sections—turned up. The stone was piled 3 to 4 ft. deep over the pipe and a little steam turned into the pipe. Several such piles kept going all the time supplied enough stone for the work; the stone was never overheated, and was moist enough not to dry out the mortar when mixed with it. In this manner the concreting was successfully carried on and the wing dam built high enough to keep high water out of the forebay.

Some danger from freezing was also encountered the next season, when the last part of the

wing dam was being constructed. This work was done when the temperature was close to freezing, and it became necessary to keep the freshly placed concrete warm over night. This was done by covering the work loosely with canvas, under which the nozzle of a steam hose was introduced. By keeping a little steam going all night the concrete was easily kept above freezing temperature.

FIG. 10. VIEW OF CHAUDIERE FALLS FROM BELOW AFTER COMPLETION OF WORK.

TRAVELER FOR BUILDING MAIN DAM.—The main dam was started from both ends. Wing cofferdams were thrown out into the river, with short lengths of cofferdam or cribwork running dowstream at their ends; by taking due advantage of the rock ledges projecting from the bed of the river, a large space at and below the site of the dam was laid dry. This arrangement made it possible to use in the construction of the dam a traveling mixer platform set above and straddling the dam, by which the work could be carried on very rapidly and economically.

The traveling platform is shown in Fig. 11. The legs clear the dam by 5 ft. on either side. The top carries two platforms, 6 ft. apart vertically. On the lower platform was mounted a Drake single-screw mixer, driven by a small vertical engine. The mixer discharged the concrete into the upper end of a tube fitted with a lower telescoping section, by means of which the concrete could be deposited directly on any part of the dam. The upper platform was used for charging the mixer, having a hole for the purpose, 2 ft. sq. over the charging end of the mixer. The material was supplied to this platform by a traveling stiff-leg derrick with 35 ft. boom, just south of the traveler platform; this derrick ran on rails 25 ft. apart, and the boiler of its hoisting engine supplied steam also to the mixer engine. The derrick in turn was supplied with cement, sand and broken stone by a 3-ft. gage track running from the bins and crusher on the west bank of the river to alongside the derrick.

TEMPORARY DAMS.—The cofferdam and cribwork required was quite extensive, and was made difficult by reason of the uneven rock bottom, the rapid current, and the sudden floods. The first work of this nature became necessary early in the construction, when the forebay and entrance crib were built; a cribwork cofferdam, called No. 1, was carried from the island just south of the forebay northward to a rock ledge projecting above low water level. The location of this cofferdam is shown in the general plan, Fig. 1. The spur cofferdam No. 1A was also built at this time.

The construction of these cofferdams is made clear by the cross-section given in Fig. 13. The cofferdam No. 1 was especially strong and enduring; in the highwater of spring, 1900, there were ice cakes 7 ft. thick pounding over it, and later there was a depth of 14 ft. of water over its top, yet the structure was undamaged.

The cofferdams and cribs required to lay dry the site of the main dam while the latter was under construction are also shown, as to location, in Fig. 1. The sections of cribwork shown in the space near the center, between the cofferdams running out from the two banks, were arranged so that the openings between them could be closed by stop-logs and the water turned through the forebay and over the wing dam through the main sluice way, and also through three temporary sluices left in the westerly half of the main dam. Thus the closing section of the dam at the center could be constructed, and later the temporary sluices concreted in. The style of construction of the main cofferdams protecting the dam site is shown in Fig. 13, where a section through cofferdam No. 3 is given. The cribs were similarly simple stone-filled log cribs with vertical sides, suitably fitted with stoplog grooves. This temporary work was built mainly by Mr. D. E. Waite, of Holyoke, Mass., as foreman, who carried it out in remarkably short time and at low cost. A difficult log trestle, for hauling material cars by cable, crossing the river just above the brink of the falls, and used in some of the work in the forebay, was also built by him; a portion of this trestle is shown in Fig. 14.

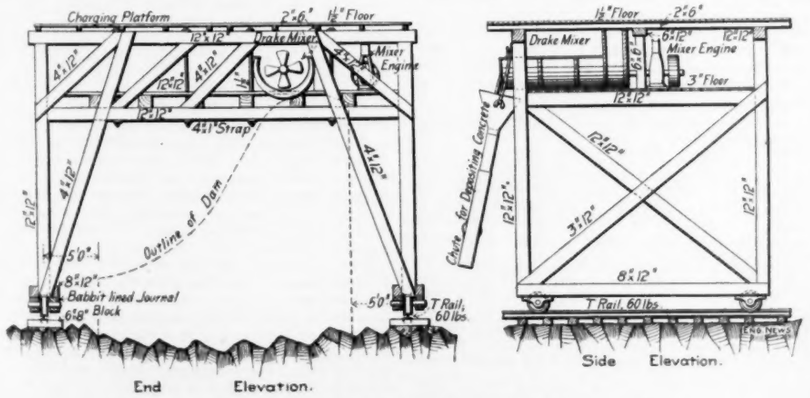


FIG. 11. TRAVELING PLATFORM FOR BUILDING MAIN DAM.

POWER TRANSMISSION BY SUBAQUEOUS CABLE.

The original scheme for the development of the power of Chaudière Falls contemplated the transmission of power to Quebec by way of the bridge across the St. Lawrence which is at present being built. As much as a year ago, however, it became highly desirable to be able to transmit power to Quebec without waiting for the completion of the bridge. During the summer of 1901, therefore, a cable was laid across the St. Lawrence by the Safety Insulated Wire & Cable Co., of New York, which cable connects at Levis with the substation fed from the main transmission line and at its other end supplies about 1,000 HP. of electricity to the Quebec Railway, Light and Power Co. In reference to this cable transmission Mr. A. R. Henry, General Superintendent of the Canadian Electric Light Co., has kindly supplied us with the following information:

The employment of an aerial suspended line, as

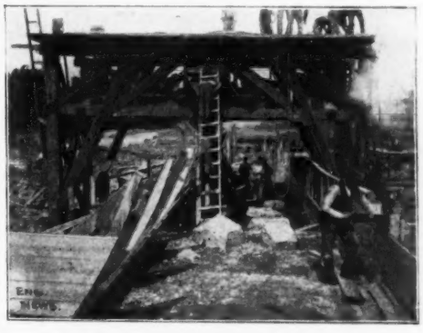


Fig. 12. View of Traveling Platform in Operation; Concreting Portion of Main Dam.

at the Carquinez Straits crossing of the Bay Counties Power Co., in California, was considered too expensive and hazardous, the span required being about 4,500 ft. The cable method of transmission was therefore adopted. The transmission is by two-phase alternating current of a frequency of 66⅔ cycles, at 2,300 volts.

The cable is composed of four stranded conductors and four No. 14 B. & S. gage pressure wires; the length of the cable is about 4,350 ft. Each conductor is composed of 19 tinned copper wires, No. 14, B. & S. gage; the strand is surrounded by an insulating layer of Para rubber of a minimum thickness of ⅛-in., and is then wrapped with rubber-filled tape. The four conductors, and the four pressure wires, similarly insulated and aped, are twisted around a jute center, the whole wrapped with tape and served with two layers of tarred jute. The cable is armored with 30 No. 6 galvanized steel wires. The outside diameter of the completed cable is 2 5-16 ins., and its weight is 6½ lbs. per lineal foot.

The cable was laid in December, 1901, by a lighter fitted with cable reel, winches, and the necessary brakes. An ice breaking steamer, belonging to the Quebec & Levis Ferry Co. was used to keep a passage clear for the lighter, which

was successfully done, although the ice was from 8 ins. to 2 ft. thick.

At each shore the cable terminates on a pole, in a 4-in. bell filled with micanite compound. Lightning arresters are also mounted on these poles. On the Quebec side the conductors are connected directly to the bus-bars of the Quebec Railway, Light and Power Co.; the pressure wires are also connected to these bus-bars and lead to recording volt meters on the Levis side, so that the attendant at the Levis substation can regulate the voltage to suit the drop in the cable.

The substation equipment at Levis, for the transmission cable, consists of six 200-KW. air blast transformers and two 150-KW. oil cooled transformers, which reduce the voltage from 10,000 to 2,080 normal; the secondary voltage may be raised to 2,700 volts, suitable regulating dials being provided for this purpose on the transformers. The cable has been in continuous use since February of the present year, and the transmission is giving complete satisfaction.

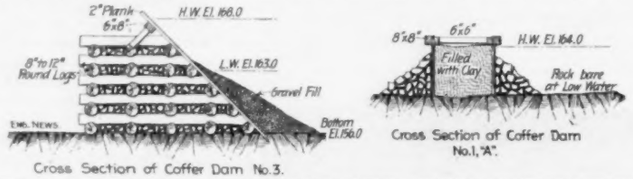


FIG. 13. SECTIONS OF COFFERDAMS USED DURING CONSTRUCTION.

MEDICAL AND SURGICAL KITS FOR ENGINEERS: A SYMPOSIUM.

In our issue of Jan. 1, we asked for suggestions as to the make-up of medicine kits, suitable for the use of survey parties, explorers, etc. Naturally the demands on such an outfit will vary with the size and make-up of the party, climate, and the distance from a base of supplies, and from skilled medical attendance, together with the length of time it is expected to remain in the field. We have received a considerable number of

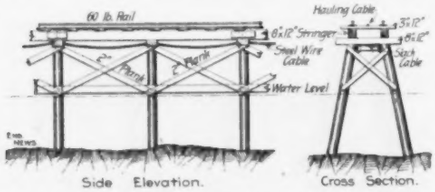


Fig. 14. Log Trestle for Supply Track Used During Construction.

replies in response to this request, and have selected the following letters for publication:

Sir: You may be interested in the medicine kit kept at the laboratory of the blast furnace of the Salem Iron Co. of this place:

Carbolated vaseline—For cuts;
Mixture linseed oil and lime water—For burns and scalds;
Absorbent cotton and unbleached muslin—For cuts, burns and scalds;
Tincture arnica—For sprains;
Ammonia water—For gas poisoning (inhaled);
Aromatic spirits of ammonia—For gas poisoning (taken internally, diluted in water);
Jamaica ginger—For summer complaint;
Cocaine (4% solution)—For dropping into the eye before removing foreign matter;
Telephone—For calling the doctor;
Stretcher—For carrying off the disabled patient, if necessary.

Yours truly,
Harrison Everett Ashley, Chemist.

Leetonia, O., Jan. 2, 1903.

Sir: I have a small medicine chest that was filled for me by the German Hospital in Philadelphia, and, in hope that it will be of interest to some of your readers I will give a list of its contents:

Tinct. of arnica,	Spirits of Camphor,
Sweet spirits of Niter,	Pil. Cathartic Comp.,
Pil. Quin. Sulph.,	Bi-Carb. Soda,
Calomel,	Pil. Aloin. Strch. and Bellad.,
Caffeine Comp.,	Chlorate of Potash,
Laudanum,	Ox. Zinc Ointment,
Arom. Spirit of Ammonia,	Boracic Acid Ointment,
Dover's Powders,	Carbolized Cosmoline,
Ess. of Jamaica Ginger,	Adhesive Plaster,
Ess. of Peppermint,	Bandages.
Paregoric,	

Yours truly,
Geo. K. Erben, Engineer.

Office of Asst. Engineer, Western Pocahontas Coal & Lumber Co., Beckley, W. Va., Jan. 19, 1903.

Sir: Fraser's medicine chest, No. 608, which is made of leather, 7 ins. long, 5¾ ins. wide and 5 ins. high, containing two 4-oz. and 6 2-oz. glass stoppered bottles, and a space for sundries (Dover's powder, 5-gr tablets; cathartic pills, etc., for instance), for a short camping outfit, would be a very admirable medicine kit, filled as follows: The two larger bottles, with castor oil, and Brown mixture (mixture glycyrhiz. comp.) for coughs and colds (tablespoonful doses), and the six smaller bottles respectively with Tincture of ginger; Worburg's tincture for fevers (teaspoonful at a dose, say every 3 hrs.); Sun cholera mixture with dose on bottle; sweet oil and carbolic acid (1 in 20 solution) for application to sores and wounds only; rhubarb and bocarbonate of soda mixture; wine of ipecac (which has the same dose as syrup and does not spoil); (bromide of potash, 5-gr. tablets, and soda mint tablets also could be carried as sundries). The Dover's powder is safer for layman's treatment of pain than morphine would be.

Yours truly, M. D.

New York city, Jan. 10, 1903.

Sir: In response to your request for suggestions concerning light medicine kits, I send you a brief description of one that I had made for one of my parties last summer. The work in hand was the survey of a part of the Grand Canyon of the Gunnison, and was of so difficult a nature that the danger of serious injuries was very great, and for this reason the kit was planned rather with reference to possible accidents than to sickness. The case was made of leather in the form of a box 5 × 6 × 9 ins., the top being left unsewed and supplied with a flap which buckles down over the front. A ring is riveted to each end for attaching a shoulder strap if desired and a handle is riveted to the top. The case contains, closely packed, 1 roll adhesive plaster, 4 rolls cotton bandage (assorted sizes), 2 rolls gauze bandage, 1 yd. Red Cross gauze, 1 1-oz. package absorbent cotton, 1 paper court plaster, 1 package mustard plasters, 1 bottle vaseline, 1 ½-pint flask brandy, 1 tourniquet, 1 small bottle Jamaica ginger, and 1 medical case, size 1 × 3½ × 7½ ins., containing 10 small wide-mouthed bottles all numbered and referred to a set of directions in the pocket, which also contains directions as to what should be done in case of injury or poisoning. This smaller case contains the following remedies, all in tablet form: No. 1 for constipation; No. 2, diarrhoea; No. 3, coryza; No. 4, dyspepsia; No. 5, (calomel) fever, tonsilitis or torpid livers; No. 6 (Dover's powders) chill, insomnia, or pains; No. 7 (quinine), fever; No. 8 (megraine), headache; No. 9 (bromides), insomnia; No. 10, antiseptic tablets for external washes.

This outfit occupies but little space, is easily and safely packed and thus far has met every want of a good-sized party engaged in very arduous surveying extending well into the winter.

A. L. F.

Montrose, Colo., Jan. 24, 1903.

Sir: Apropos of your article in Engineering News of Dec. 11, on "A Prospector's Grub Stake," and Mr. H. M. Wilson's letter in your issue of Jan. 15, on "Ration List for U. S. Geological Survey Parties," I submit a list of medicines for a rough-and-ready camp medicine chest. This list I have used with success in a contractor's camp, and for an engineering party. I give the amount of each drug I buy at one time, and the general use I put it to for different complaints:

1 bottle Phenol Sodique (antiseptic)—Burns, gunshots, cuts, bruises, etc.;
1 lb. Stoke's Liniment—Bruises, sprains, etc.;
1 lb. Turpentine—Cuts, bruises, sprains, colds and grippe;
1 lb. Witch Hazel—Bruises, sprains, soreness of limbs, etc.;
1 lb. Peru Oil—For dressing cuts and various wounds;
100 tablets Bernay T. T. No. 695—Washing foul sores;
¼-lb. Hydrogen peroxide—For cleansing sores that run matter;
1 lb. Glykaolin—Frost bites, bruises, aches, etc., where skin is not broken;
100 tablets 5-gr. Dover's Powders—Colds, grippe, etc.;
1,000 tablets Brown Mixture Comp.—Coughs, colds, etc.
100 tablets 1-60-gr. Strychnine Sulph.—Colds, etc., when severe;
½-lb. Quinine (sulphate)—Colds, fever, chills, etc.;
500 1-gr. Calomel tablets—Colds, fever, excess bile, chills, boils, etc.;
2 doz. Seidlitz Powders—In connection with calomel;
1 lb. White Pine Tar Syrup—Coughs;
1 lb. Glycerine—Colds, sore throat, chapped hands, foot sweats;
1 lb. Squibb's Mixure—Diarrhoea, dysentery, colic, etc.;
1 lb. Soda—Sour stomach, etc.;
1 lb. Compound Cathartic Pills—Constipation, etc.;
100 Ladactic Pills—Sour stomach and heartburn;
½-lb. Jamaica Ginger (Essence)—Various stomach and bowel trouble;
½-lb. Castor Oil—Constipation, colds, etc.;
2 lbs. Epsom Salts—Constipation, headaches, etc.;
500 tablets Wyeth's Acetanilid and Sodium Compound No. 1—Headache—especially when caused by working with dynamite;
1 oz. 15-gr. Aspirin Powders—Nervousness, pain, etc.;
500 5-gr. Antikamnia—Headache, neuralgia, etc.;
1 doz. bottles Bromo Seltzer—Headache etc.;
4 oz. Acetanilid—Headache, neuralgia, etc.;
1 lb. Cream Tartar—Painful or scanty urine;
½-lb. Spirits of Nitre—Urinal trouble;
½-lb. Camphor—To settle stomach after vomiting;
¼-lb. Sweet Oil—Earache;
½-lb. Laudanum—Earache, stomach and bowel complaint;
½-lb. Charcoal—Heartburn;
2 oz. Oil of Cloves—Toothache;
2 boxes Mennen's Toilet Powder—For rash, and prickly heat;
2 boxes DeWitt's Witch Hazel Salve—Chapping of legs, boils, etc.;
1 lb. Borax—Sore and tender feet;
100 tablets Morphine and atropine No. 2—For hypodermatic syringe;
100 empty capsules, No. 0; 100 empty capsules, No. 2;
1 lb Chloroform or ether, 2 lbs. Absorbent Cotton, 2 lbs. Cotton Bandages, 4 yds. Linton Moist Gauze, 20 yds. 2-in. Adhesive Plaster, 1-yd. Belladonna Plaster, ½-lb. Carbolic Soap, 1 lb. Carbolic Acid—For accidents such as gunshots, explosions, falls from cliffs, and bad injuries from machinery.

½-lb. Chesebrough Vaseline,	1 Teaspoon
1 bx. Lee's Mustard Plasters,	1 Case Knife,
1 Hypodermic Syringe,	1 small pair Surgeon's Tweezers,
1 Medicine dropper,	
2 pairs Dentist's Forceps,	1 small Surgeon's scalpel
6 Surgeon's Needles,	1 Hot water Bag,
3 cards Surgeon's Silk,	2 Rubber Bandages.

Some of these drugs should be handled with care, and only used when "the administrator of drugs" has had some experience in treating sick men, but the most of them can be given for ordinary ailments without fear of overdose. Of course, the writer is not a physician, and he would not attempt to advise the amount of each medicine to be used for a dose, but by consulting some physician before starting camp, any one could post themselves enough to give the above list of medicines. Whiskey has been left out purposely, as the writer only knows of one case where he would recommend it, without a physician's prescription, namely, for snake bite. A chest can easily be made to carry the drugs from one camp to another, and the bottles, etc., can be refilled at convenient times. Many physicians could no doubt furnish a better list, but this one has been made up from actual needs, and has proved satisfactory. Others may be able to use it.

Yours truly,
Daniel J. Hauer.

La Follette, Tenn., Jan. 27, 1903.

Sir: In response to a request for suggestions about a compact medicine chest for a surveying party, the writer feels called upon to give the benefit of his experience. On his first trip he was under a chief who knew absolutely nothing about medicine or surgery, and the party had, as most railroad engineering parties in the West have, a medicine chest prepared under the direction of the chief surgeon of the company. It was an awkward box about 12 ins. in each dimension and not nearly filled. On the inside cover was a printed slip of directions. On that trip nearly everything happened. We had bandages, but nobody knew anything about bandaging. We had a big supply of compound cathartic pills and a big supply of quinine pills; some permanganate of potash for snake bites, listerine for cuts and wounds and a lot of nicely sealed up little bottles, looked at with awe and fear, and untouched for fear of potent influences which might be unwittingly let loose. The box was a nuisance.

The following winter, having plenty of time on his hands the writer (having been reared a Homeopathist) took a course of lectures on materia medica and therapeutics in the local medical school, by arrangements made by the family physician and took also a course ticket for lectures on "first aid." Since then he has arranged his own medicine chests.

In doing this it must be borne in mind that only common complaints and accidents are to be treated. Serious things are to be merely treated until competent help can be secured. The first thing the engineer should put in his chest should be a "First Aid" book. There are several in the market, and the cost ranges from 75 cts. to $1.25. He will be told how to attend to cuts in veins and arteries and how to treat fractures; how to resuscitate drowning persons, etc. A common school physiology is a useful book also. If the chief does not care for this sort of reading, there is sure to be some one in the party from the cook to the transitman who will read such books, and it is a good plan to start them out on the first day as a sort of circulating library. This has been the writer's practice.

Court plaster is the first thing the amateur surgeon provides himself with. Care should be used in applying it. If applied to an abrasion it will usually retard the healing. An abrasion should be first washed carefully with an antiseptic wash, and then it can be let alone, care being used to use in washing only the best of soap and a selected towel or clean cloth for drying. It will get well by being simply kept clean. If on a portion of the body where the exudation is annoying and liable to cause the newly formed skin from time to time to be torn away, wash in an antiseptic wash and powder with boracic acid and put on a small piece of absorbent cotton. This can be kept in place by several crossed narrow strips of court plaster. The treatment of cuts and abrasions, and, in fact, all sorts of wounds, is simply cleanliness. But with an abrasion it is bad to keep away the air as will be done by the use of a piece of court plaster, besides which the court plaster is liable to adhere to the wounded surface instead of to the skin around the wound and from time to time will tear it away. Court plaster is of use principally in

binding together the edges of cuts after they have been cleansed. Give nature a chance to heal and that is all that is necessary.

Iodoform is a nasty smelling dressing, and among a crowd of men is suggestive, and leads to coarse joking. The writer prefers boracic acid as being thoroughly efficient and odorless. It comes in powdered form, and can be used ad lib. In the medicine chest, then, put a bottle of boracic acid, a package of court plaster (the thin transparent kind is the best), a package of absorbent cotton and several rolls of bandages of different widths. For soap to wash cuts, wounds generally and abrasions the writer prefers in the following order, borax soap, Ivory soap and white castile. The white castile might stand first, if we had confidence in its purity, and of its being genuine castile. Contrary to the accepted impression, it does not smart to freely wash a wound with tepid water and pure soap. Among antiseptic washes Listerine is easily first and Formalide is next. But that is a matter of opinion. Take a bottle then of one or the other.

Put in the box a pair of good scissors, and see that the draftsman and cook do not use them, and absolutely prohibit touching them by any man having seamstress work to perform. They are a part of the surgical outfit and must positively be ready when wanted. Put in a pair of tweezers for extracting splinters and a lancet is also a good thing to have. A box about 12 ins. long, 8 ins. wide and 4 ins. high should hold the outfit.

A word about burns: These occur many times when the men load cartridges too near a fire and once in a while from the explosion of a fresh branch in a campfire. The treatment of burns is to keep the air excluded. Nature will do the rest. When one-fourth the body is burned, it is serious; if one-third is burned it is a critical thing, and if half the body is burned it is fatal nine times out of ten. Nature is crowded to repair the damage and there is great danger of blood poisoning. The best dressing to apply quickly is a paste of common white flour and olive oil, something to be found in every camp. Plaster it on thickly and bandage, first pricking all the blisters. Then make a solution of lime water and put it into a bottle with olive oil and make an emulsion. Use this as a dressing until the wounds are healed. The flour and oil paste can be left on and simply kept moist with the emulsion. The process of healing will be rapid if the blood of the patient is in fairly good condition. The writer has had recommended to him a dressing of olive oil and camphophenique, but has not had an opportunity to try it yet. It is a good idea to carry a bottle of lime water or a tin box with some lime in to prepare the water when required. Prompt action is necessary.

For rattlesnake bites jab the wound with a sharp knife and rub into it some grains of permanganate of potash crystals. It will bring the poison foaming out. From the color of the blood determine whether a vein or an artery has been pierced by the serpent's fangs, and tie a tourniquet on the right side of the wound. The wound will give little trouble. It is well when in a country infested with rattlers to make each man carry in his pocket a half-dram bottle with the crystals in and have one blade of his knife kept as sharp as a razor to open the wound to make the blood run freely. It must run out. Fear to make a generous enough incision may cost a man his life. Whiskey and brandy are poor things to depend upon for snake bites as they must be on the spot the moment they are required and must be in quantities. If carried in the medicine chest the men will be having cramps and all sorts of disorders which only those things will relieve, and usually when the snake bite comes no liquor is at hand. The writer never takes whiskey and brandy along for medicinal purposes, and, in fact, it is better to keep them out of camp altogether.

So much for surgery. For medicinal use a very few medicines will do. It is usual to take along a large quantity of compound cathartic pills, for constipation attacks the men frequently.

Until they get accustomed to camp routine men are liable to neglect some things and a few days after starting out they make a demand for compound cathartics, and the demand continues. The writer believes this jerky method of doing things is wrong. It is merely an alternation from day to day of extreme conditions. It is far better to supply each man a day or two before starting out with some mild vegetable laxative pills, and put in a supply to use if anything goes wrong on the trip.

Another condition liable to arise is of an opposite nature caused by the changing of water, etc., though not nearly so likely as constipation. Some cholera cure is generally packed in on the theory of "strong men, strong medicines." Stanley says, in one of his books, that the natives in the interior of Africa liked him to give them medicine which tied them in a knot. The writer has had men in every party he has been in who acted exactly like the natives mentioned by Stanley. The best treatment of a loose condition of the bowels is to refrain for a few days entirely from the eating of vegetables and fruit, and eat as much meat as possible and bread and toast and drink coffee. Drink as little water as possible. For constipation drink no coffee, eat no meat, eat plenty of vegetables and dessert of all kinds and drink all the water possible. A good drink of water immediately on arising in the morning and before retiring at night will promote a movement of the bowels if not too seriously out of order. There is no occasion for alarm before the third day. Then is time to begin work with the medicine. If a laxative, take it until regular movement commences. If a diarrhoea remedy is taken, be careful not to produce too opposite an effect. For diarrhoea, diet is the best thing, although Chamberlain's diarrhoea remedy is good when absolutely needed. If diarrhoea is checked it is sometimes necessary to immediately commence with laxatives until regularity is again established.

Rheumatism troubles the men frequently. For this the writer has used Mexican Mustang Liniment successfully, and believes it a fine thing to take along. H. H. H. horse liniment is fine also and as these can be obtained at every drug store the supply can readily be renewed. They are good also for a heavy cold on the chest. If they cannot be obtained, an excellent liniment can be made of sassafras, ammonia and olive oil, well shaken together. It is to be rubbed in well. Plenty of oil and sassafras and a very little ammonia.

For piles the Anusol Suppositories from Messrs. Schering & Glatz, New York, are positively the best thing the writer has had experience with, personally and with others, effecting in his case a complete cure.

Colds are the bane of life until the men get accustomed to outdoor existence. Colds generally occur because the men try to take too good care not to take them and sometimes relax their vigilance. Sensible living is required. Do not muffle too much, and avoid sitting in drafts. If the feet are wet and it is impossible to secure a change of socks, take off the socks and wring them thoroughly. Dry the feet and replace the socks, pour the water from the boots and put them on. Then sit by the fire until the boots are dry. Snuffles in the head will rarely follow this treatment. But to go around with half freezing feet or to get up from the fire and allow the feet to get damp and cold will surely produce a cold. If the feet do not feel warm, do not go to bed until they are warm, even if not dry. When bed time comes put the socks to dry with the shoes if a fire is kept up. If no fire is kept up take the socks off the feet and put them in the bed next the body and they will finish drying during the night. To sleep with socks on is a filthy habit and makes the feet sore. In short, to avoid taking cold try and keep the clothes dry, but if wet and no change can be made, dry clothes and body together at a fire. If perspiring freely, do not go into a cool place to dry off. Simply walk around at an even pace until the sense of perspiring vanishes and no chilly feeling remains, or, dry off next a fire, or where the temperature is fairly even and at about body heat, or a little warmer.

The cold once contracted can be greatly helped by rubbing the stiff and sore places with one of the liniments mentioned, and by the use of porous plasters on the chest or back. The writer is greatly opposed to the use of quinine pills. Men who use them are too often the men who have great faith in the medicine and neglect ordinary precautions. Quinine is too apt to cause a loosening of the skin and create a tendency to take cold again while relieving the cold for which it is taken. He is opposed also to the use of various bromide preparations of a laxative nature. They are good while at home generally, but in camp where the extremes of temperature follow quickly in tents and around fires there is a certain risk in their use. The writer has also seen men brought near to death's door by trying to sweat out a cold. They pile clothing on themselves in the tent and imbibe whiskey and quinine. If the same care could be taken of them in the tent that they could receive in a room it might work. Generally it is a bad thing to try, especially if the cold is severe.

Thus far the writer has tried to avoid doing violence to men's feelings by advocating any particular school of medicine. But he cannot help saying that he would rather have a small case of Homeopathic remedies for constipation, diarrhoea, colds, etc., than anything else. A case of 12 remedies can be carried very easily, and will be sufficient to treat all simple disorders, and if the man dispensing the remedies knows what he is doing, or has had much experience, he can treat illness when it is quite serious. The best way to take Homeopathic remedies is in two drachm bottles of liquids, and then carry along a half pound or so of pellets or disks, and a lot of empty two-drachm vials and corks. He can then fill an empty bottle with the pellets and medicate them when needed. Messrs. Roericke & Schreck, Philadelphia, and San Francisco, and Luyties' Homeopathic Pharmacists, St. Louis, can supply the materials together with a small book for handy use. The total cost need not exceed $5. There is absolutely no danger in their use and their efficacy is remarkable when administered wisely. The writer recommends as the dozen best remedies for the surveying party: China (Homeopathic quinine), Arsenicum (Homeopathic strychnine), Aconite, Belladonna, Bryonia, Mercurius (this does not keep well in liquid form and should be in disks or pellets), Nux Vomica, Phosphorus, Pulsatilla, Rhus Tox (the preventative for poison oak and a good cure for it also) Sulphur and Hepar Sulphur. Variolanium in powdered form is a good thing to take along as a preventative of smallpox. If in the vicinity of smallpox cases it is well to have every man take a couple of powders every day. The Homeopathic pharmacies also keep what are known as Special Prescription tablets. Sometimes the engineer would do well, if he is doubtful otherwise of his ability to prescribe, to lay in a stock of these tablets instead of the regular Homeopathic remedies as mentioned above. A book sufficient to give safe information to the tyro can be procured for 50 to 75 cts.

The Abbott Alkaloid Co., Chicago, can furnish alkaloidal remedies. These remedies were gotten up for what are termed, Regular Physicians (as distinguished from Homeopathic, Eclectic, etc.) to give small doses and yet not abandon the Allopathic principle entirely. Homeopaths say "like cures like." In other words any drug producing a certain physiological effect on a healthy person in a large does will have an entirely opposite effect in a small dose. They therefore practically treat symptoms and this example may suffice. Belladonna in a large does will dilate the pupils of the eyes. If the pupils are dilated too much the Homeopath will give Belladonna. Now the physician who uses the Alkaloidal remedies may have a case requiring the administration of Belladonna. Instead of giving it in a very small dose at long intervals he will give it in very small doses at frequently recurring intervals until its most marked physiological effect is observed. Then he gives smaller doses at very much longer intervals. The writer has a great deal of confidence in the Alkaloidal school. The remedies oftentimes act more quickly than Homeopathic remedies, and it is generally easier to get the men to take them and they have generally more confidence in them.

The Alkaloidal remedies can be obtained from the above firm. A suitable box and book can be had for from $3 to $5. Generally, they are in bottles each labelled for a particular disease or complaint. The dosage is also marked. It is perfectly safe to use them. For inflamed tonsils the Homeopathic remedies best to use under most conditions are Mercurius and Belladonna. No particular effect is felt, but the swelling goes down in a short time. But to take the Alkaloidal Tonsilitis pellets repeated every half hour gives one, after the second dose and some times after the first dose a very queer feeling of constriction and drawing in the tonsils. Homeopathic and Alkaloidal remedies are specific.

In this article the writer has attempted to be as fair to two opposing factions in the medical world as he can be. He believes every regular practitioner will endorse his remarks about the homely remedies recommended, and believes there has been nothing recommended, anywhere to which a Homeopath would object. Both Regular and Homeopathic physicians use the Alkaloidal pellets and tablets more or less. The remedies recommended are recommended only after personal experience.

For all sorts of swellings and inflammations, such as insect bites, poison oak, etc., the hottest kind of water is the best thing. It can be mixed with Extract Witch Hazel or the extract can be used alone. This extract can be purchased in original packages or in bulk. In bulk (so a druggist informed the writer) it is largely adulterated with water and the majority of druggists put in more water when they purchase it. So when purchased in bulk a very large quantity can be obtained for the price paid for a small bottle as put up by the manufacturer. Tie a bandage around the inflamed part and keep it saturated with the extract until reduced. A fiery swelling around a wound with much pus is generally evidence of blood poisoning and oftentimes it should be opened with the lancet and swabbed with Peroxide of Hydrogen, if no surgeon is available. Peroxide of Hydrogen is a very useful thing to use to swab the throat if evidences of diphtheria appear. But it is not essential to have it on a trip, if Listerine or Formalide are taken.

For Poison Oak poisoning nothing is equal to hot water and common washing soda in strong solution. Heat the water until nearly boiling. Then add the soda and mix well. Swab the affected places freely until the water cools, then heat some more and throw away the other stuff together with the piece of cotton used as a swab. The writer was engaged in running a line in California through a thicket of Poison Oak, and the brush cutters quit because of fear of the stuff. As he had before that time never been affected, except around the edges of scratches or cuts of briers in poison oak thickets, he stepped in and cut about 200 ft. through the thicket himself. It was hot work and perspiration was free. The job was completed at dusk, so work was stopped and in a few minutes all were in camp. The wise thing to have done would have been to have washed the hands (which were stained in places with juice, which turns black) first in a strong solution of hot water and soda, and to have poured the water out, washing the face afterward in another similar solution. But that was not thought of and the face and hands were washed as usual. In the morning he could not see and his eyes were completely closed by the swelling. His hands and face were badly puffed and it was impossible even to eat. But that he might be said to be practically immune was shown by the fact that no other parts of his body were affected. His hands had been wet and stained by the juice and he had rubbed it into his perspiring face.

A bucket of water and a package of soda and a small one-burner kerosene lamp were taken to his room. He placed the lamp in a chair and kneeled by it all day heating water and making his soda mixture and swabbing himself. It was a continuous operation for a quick cure was necessary. That night his hands looked like the

hands of a washerwoman, shrunken and wrinkled and peeling. His face was practically in shape again and his eyes fairly wide open. Before retiring for the night, soda and ammonia and Pond's Extract were mixed and a final swab of the fiery mixture put on. By morning he was ready for work, except for the fact that his eyes pained by reason of such severe remedies being used so close to them. In the afternoon he went to work again after the loss of only a day and a half. The precaution was taken then to wash the face well in a solution of very strong common washing soap and soda water, letting it dry on the face and the hands before going to work. In the afternoon when work was stopped the hands were washed first and then the face. Some men are not so fortunate.

Immunes to Poison Oak chew twigs. They say this makes them immune and the idea is fascinating to a Homeopathist, but the writer prefers to use Rhus Tox, which is the Homeopathic preparation of Poison Oak. The twigs seem to be safe to chew and make a tea of as some Mexicans do, but the leaves seem to be very dangerous if a steeping of them is taken inwardly or even applied outwardly. Your truly,

Ernest McCullough.

Lewiston, Idaho, Jan. 14, 1903.

AN INTERESTING BOILER EXPLOSION.

By A. H. Smith.*

One of the boilers of the Republic Iron & Steel Co.'s plant in Toledo, O., exploded at about 4 a. m. Monday, March 16, 1903, resulting in the death of two men, the engineer and the water tender. This boiler was a 200-HP. Cook vertical water-tube boiler and furnished the power for operating the 8-in. mill. The accompanying sketch, Fig. 1, shows its general form and its setting.

The steam dome was 6 ft. in diameter and 6 ft. high. The mud drum was 6 ft. in diameter and about 3 ft. 6 ins. high. These were connected by a central 12-in. tube and also by 95 4-in. water-tubes 18 ft. long. The heads and tube sheets were of 9-16-in. metal and the shells were of 7-16-in. metal.

The steam dome had at its top an 8-in. nipple terminating in a tee. To one outlet of this tee was connected a 4-in. pop safety valve and to the other outlet was connected the steam pipe going

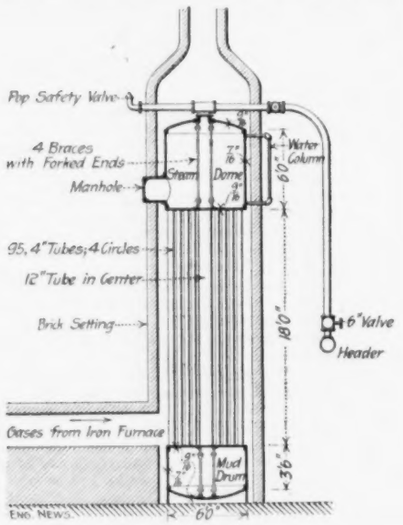


Fig. 1. Vertical Section of 200-HP. Cook Vertical Water Tube Boiler and Setting in Mill of Republic Iron & Steel Co., Toledo, Ohio.

to the main steam line or heater. On the side of the dome were also the manhole and the water column connections. The top and bottom head of the dome were connected by means of four braces. The mud drum had feed-water and blow-off connections and a manhole, and its top and bottom heads were tied together by four braces in the same manner as the steam drum. The boiler was enclosed in the usual brick setting, terminating at the top in an iron stack. Steam was generated by means of the waste heat from an iron furnace.

From the coroner's report and from the report of the Examiner of Steam Engineers the following data concerning the explosion are obtained. This boiler was cleaned the day previous to the explosion, the 6-in. valve in the steam pipe being closed for this purpose. Fire was started early Monday morning and about four o'clock the water tender called the engineer's attention to the high steam-pressure in the boiler, whereupon the engineer ordered him to open the 6-in. valve which had been left closed. Steam pressure was now 180 lbs. and just about the time the valve was

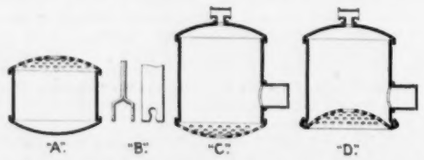


Fig. 2. Sketches of Mud Drum and Steam Drums.

being opened the boiler exploded, instantly killing the water tender and fatally injuring the engineer, who was able to make the above statement four or five hours after the accident.

Had the workmen been there many of them would have necessarily been killed or injured as the explosion blew out the entire end of the building which was of metal construction, and filled the surrounding area with bricks, water tubes and miscellaneous debris.

The brick setting of the boiler was entirely de-

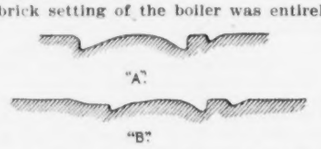


Fig. 3. Prints Made in the Ground by Steam Drum.

stroyed. The mud drum remained in place. In its tube sheet were remaining the 12-in. central tube and a dozen or more of the 4-in. tubes. This tube sheet was convexed about 6 ins. by the force of the explosion and presented the appearance shown in the accompanying sketch (A, Fig. 2). The braces in this drum were all broken, most of them having failed by opening or splitting out at the end beyond the pin, as sketched at B, Fig. 2.

The remainder of the water-tubes were scattered within a radius of about a hundrd feet, several of them going some distance farther but none of them going with the steam dome. This steam dome, whose weight is about 3,000 lbs., made the remarkable flight of 1,558 ft. before touching the earth; it then rebounded 200 ft. and then rolled end over end 337 ft. farther, stopping about 2,100 ft. from its starting point. The explosion must have convexed the tube sheet of this drum in the same manner as it did that of the mud drum (see the sketch C, Fig. 2). The imprint in the earth (which was unfrozen and city commons) was of the form sketched at A, Fig. 3, showing that the steam dome struck in almost a vertical position and then rolled over far enough to leave the imprint of the manhole connection before rebounding. The second imprint in the earth was as at B, Fig. 3, showing that the steam dome struck almost as it did the first time. At present the tube sheet is forced inward, as indicated at D, Fig. 2.

The boiler was about eight years old and had been inspected by the Boiler Insurance Co. in December. It was comparatively free from scale accumulations and the exterior appearance of the tubes was good except at the lower ends where they entered the mud drum. Here they showed some evidences of corrosion.

When the explosion took place these tubes were stripped from the tube sheets by having the beaded or expanded portion of the tube sheared off. I noticed, however, that at least one of the tubes was pulled in two and saw in the mud drum the shorter piece which was about 6 or 8 ins. long. It had been pulled in two at the point where it had been most corroded on the exterior surface, as noted above.

The header or steam main had in it a safety valve set to blow off at 85 lbs., but this boiler was cut off from the header by the 6-in. valve previously mentioned. The pop safety valve (attached to the boiler itself (see Fig. 1) was supposed to blow at 90 lbs., but the statement that the gage showed 180 lbs. would indicate that this valve was not in working order. The general impression is that the explosion was caused by excessive steam pressure due to the boiler being cut off from the steam main. It would seem, however, that a boiler carrying 90 lbs. of steam should not "let go" before the pressure reached 450 or 500 lbs., and that a boiler with a factor of safety of only 2 was anything but safe.

The following paragraph taken from the report of the examiner of steam engineers may have some weight.

I find no evidence of low water as is the usual cry, on the contrary, I feel fully convinced that the boiler had plenty of water, and my impression is that the sudden release of the high pressure by opening the valve permitted the overheated water to flash into large quantities of steam very suddenly making a pressure that was beyond the strength of the boiler to bear.

*Assistant Mechanical Engineer, Toledo Plant, American Bridge Co., Toledo, O.

HIGH-PRESSURE GAS DISTRIBUTION EXPERIENCE AT NEWTON, MASS.*

By W. A. Learned.†

Our company (the Newton & Watertown Gas Light Co., Newton, Mass) supplies 11 villages with gas, covering about 25 sq. miles of territory, branching out three to six miles from the works. The elevation of the territory varies from 18 ft. above low water to 240 ft. Four of these villages are on about the same level as the works.

The problem to be solved was to increase the pressure in the four villages and fill a holder 3½ miles away which supplies four other villages beyond. This was accomplished by the installation of a high-pressure pipe line, which is 9,000 ft. long, using 6-in. cast-iron pipe with special bell and spigot joints and the necessary compressors and condenser. This pipe line under high pressure has the capacity of a 20-in. pipe line, and serves the purpose of a supplementary supply in case of accident to the main low-pressure pipe line. This system was designed to take care of the distribution in the territory for years to come by future extensions.

The 6-in. pipe was made of cast iron by R. D. Wood & Co. with special bell and spigot joints designed by S. R. Dresser, of Bradford, Pa.

The Dresser coupling for cast-iron pipe (see section, Fig. 1.—Ed.) requires pipe cast especially for this coupling, having in place of the regular bell a smaller bell, cast with a bevel edge over which the packing fits, a packing ring of rubber, made with a V-shaped recess, and two malleable iron followers, or rings, which when drawn up by bolts, compress the rubber and make an absolutely tight joint. The construction of the coupling is such that the rubber is hermetically sealed from all action of the contents of the line or the surrounding earth.

The principal advantages are: The possibility of an absolutely gas-tight line for any pressure; the making of every joint a perfect expansion joint, doing away with all the breaks due to contraction or the settling of the pipe in the trench; the ease and facility with which pipe may be laid on top of the ground and put into the trench afterward; the saving of expense on trenches owing to the fact that a very much narrower one can be used than is possible where work must be done after the pipe is lowered, and that by the use of the insulating style of coupling the line can be made absolutely proof against all disintegration due to electrolytic action.

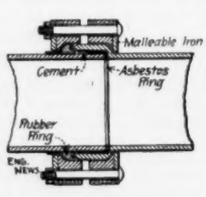


Fig. 1. Section of Dresser Joint for Cast-Iron Gas Main.

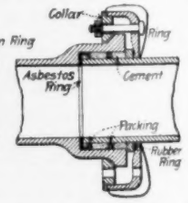


Fig. 2. Section of Clamp for Joint in Cast-Iron Gas Main.

The bends are regular fittings made with cement joints, with the style of clamp marked N. & W. The N. & W. clamp was designed to use on one mile of 6-in. pipe that was in the ground, making it a high-pressure line.

The last 1,000 ft. of pipe was laid with common 6-in. cast-iron pipe, cement joints, with N. & W. clamps, because of the non-arrival of the special pipe, and the lateness of the season. All pipes were tested with 40 lbs. air pressure. The Dresser pipe was made up on the top of the trench and lowered into position, adopting the prac-

*Abstract of a paper read before the meeting of the New England Association of Gas Engineers, at Boston, Feb. 18 and 19. The full paper was printed in the "Progressive Age" for April 15, 1903.

†General Manager of the Newton & Watertown Gas Light Co., Newton, Mass.

tice in use in the oil and natural gas regions. The cement joint pipe was laid in the usual manner in the bottom of the trench. A few hours were allowed for the cement to harden before the clamps were put on. The line was tested every night as the work progressed. The final test of two days showed an absolutely tight line. The pipes were all laid to a grade from 2 to 3 ft. below the surface, which was above the gas and water services. This was within the frost area, but the dry gas prevents any deposit, the flexible joints preventing any damage to the pipe from the action of frost or when the steam roller was at work on the top of the trench, even upon the cement joints with clamps. It did not matter how poor the cement joint was made, provided there was a hard surface at the face of the bell for the rubber to press upon. Under the worst condition the clamp joint for cement could stand 40 lbs. pressure, which is equal to 100 lbs. water pressure. The water acts as a cushion, filling up the pores of the pipe and material. The pipe line was tapped in the depressions and a 0.75-in. pipe brought to the surface to draw off any condensation.

The high-pressure line will be in operation from Nov. 1 to March 1, from sunset to 8 p. m., taking off the peak of the load in the heaviest season. The balance of the year this pipe line will be used on low-pressure service.

The compressors are of the so-called "straight line" type, made by the Rand Drill Co., 12-in. steam cylinder, 16-in. air cylinder and 16-in. stroke.

The steam cylinder is fitted with a Meyer cut-off, permitting more expansions of the steam in the cylinder than would be possible with an ordinary slide valve. It also permits the horse-power developed at the steam end to be changed at will thus permitting a wide range of pressure on the gas end without seriously interfering with the economy of the steam end.

The gas cylinder is fitted with the new Rand Imperial valves, Corliss inlet and vertical poppet outlet, giving a high volumetric efficiency and permitting the cylinders by their position to be more thoroughly water-jacketed than is usually possible.

Results of Tests on Compressor.

Boiler steam pressure, lbs.	68
Gas pressure in main, lbs.	5
Indicated horse-power, steam end	3.76
Indicated horse-power, gas end	3.78
Mechanical effect of machine, %	100
Total number of feet compressed	31,924
Duration of test, hrs.	2.75

At the end of the high-pressure line we located a low-pressure regulator, manufactured by the Chaplin-Fulton Co., Pittsburg, Pa. This was placed in a brick manhole with a suitable cover. It regulates from 20 lbs. to a few inches.

The increased candle-power and brilliancy at 5 lbs. compression can be accounted for by the decrease of the moisture in the gas. Many attempts have been made to dry the gas with the result that when it was deprived of its moisture the illuminating power was increased to a considerable extent.

By actual tests it was shown that 65% of the moisture in the gas could be taken out at 10 lbs. compression, and practically all the moisture at 20 lbs.

Naphthaline is produced when there is a deposit of aqueous vapor, and gas deprived of aqueous vapor does not deposit naphthaline under ordinary conditions of temperature and pressure.

There is no advantage gained to compress at a higher pressure than 6 lbs. to overcome friction, and remove moisture from the gas, thereby changing the color of the flame to a white light which is attractive to the public.

We pumped 18,200 ft. per hour through 6-in. pipe 9,600 ft. long, 10 lbs. initial pressure, 9.28 terminal pressure, or 0.72 lb. loss on line. Two-minute pressure observations were taken at the same time for one hour.

ELECTRIC TRAVELING CRANE WITH TRANSFER CARRIAGE.

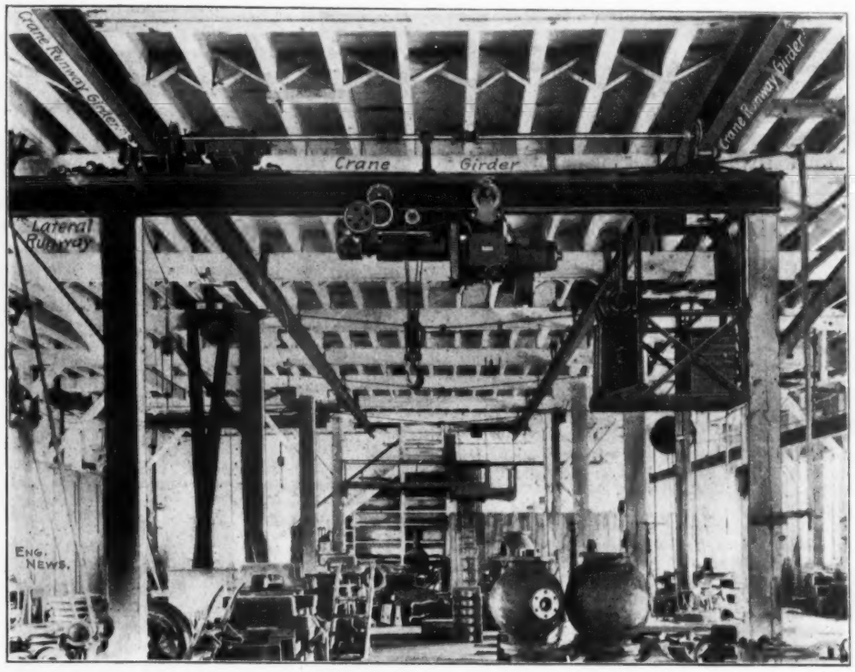
An electric traveling crane of rather unusual interest is now in operation in the sawmill machinery department of the Allis-Chalmers Co.'s works at Milwaukee, the special feature being that the trolley carrying the hoisting mechanism can be run off the crane bridge or girder upon fixed runways parallel with the crane, and at right angles to the crane runway. The hoisting and traveling motions are at all times controlled by the operator who rides in the cage attached to the crane girder.

To cover the main floor, both laterally and longitudinally, a traveling girder or bridge is furnished, as is usual in traveling cranes. This bridge consists of a single I-beam, and is equipped with trucks at each end, the wheels of which run upon the lower flanges of two I-beams forming the runway. This runway is attached to the roof girders, which makes it possible to use the bridge in connection with any number of spurs or lateral runways extending to the bays, or beyond the building. These spurs are single I-beam runways, at right angles to the crane runway, and so placed as to form extensions of the crane girder. The view shows the bridge in alinement with a spur (at the left), and one of these spurs extends through an opening in the side of the building and over a railway track and a wagon road. This gives excellent facilities for handling material between cars and wagons and the shop.

The trolley of this machine runs on the lower flanges of the crane girder or bridge. The hoisting, trolley travel, and bridge travel are all operated from a cage attached to one end of the bridge. All movements are effected through independent motors, which permit of separate or simultaneous operation, as the operator may desire. When the crane is running lengthwise of the shop, the trolley is prevented from leaving the bridge by a locking mechanism. When it is desired to run the trolley on to any spur, the bridge is stopped in line with that spur, and is there firmly locked by means of a lever in the operator's cage. The trolley cannot pass off the crane onto this spur until the bridge is in exact register, and the trolley must return to the bridge before the locking mechanism can be released to allow the crane girder to move.

The crane has a hoisting capacity of 3 tons, and is equipped with three electric motors: one for operating the hoist, one for the trolley travel and the third for moving the crane along the shop. The speeds under full and light load are as folows: hoisting 20 to 50 ft. per minute; trolley travel, 100 to 150 ft. per minute; bridge travel, 150 to 200 ft. per minute. Safety appliances are provided to hold the load in suspension at any point, to stop the hoisting motor when current is shut off, and to prevent the lower hoisting block from striking the drum.

This crane was built by Pawling & Harnischfeger, of Milwaukee, Wis., and we are indebted to the builders for photographs and other information concerning it.



TRAVELING CRANE WITH TRANSFER CARRIAGE AT THE ALLIS-CHALMERS CO.'S WORKS AT MILWAUKEE. Pawling & Harnischfeger, Milwaukee, Wis., Builders.

THE BEAUMONT OIL FIELD, WITH NOTES ON OTHER OIL FIELDS OF THE TEXAS REGION.*

By Robert T. Hill, M. Am. Inst. M. E.†

Since my paper‡ was written, nearly a year ago, many events have taken place in the Beaumont oil field. Jennings, Louisiana, and Sour Lake and Saratoga, Texas, have become productive fields. Oil is also reported in commercial quantities from several other localities. The wells of Spindle Top Hill, on the other hand, have mostly ceased to flow and are now pumped, a result which was naturally to have been expected from the drilling of nearly 300 wells within a limited space of 150 acres. All in all, the development of the field has been satisfactory; and it is safe to say that the Beaumont oil field, as a whole, notwithstanding the hundreds of experimental failures, has developed as rapidly as any other field ever discovered, and it is reasonable to expect that new localities will be found as years roll by.

The use of the crude oil has steadily increased until this material, which, at the time of its discovery, was pronounced to be unfit for any purpose, is now refined, and sells for as high as 60 to 70 cts. a barrel. All of the railways of Texas are using oil, and the Southern Pacific Ry. has recently purchased the entire Saratoga fields, and runs its engines from the Atlantic to the Pacific with the Texas material. The legitimate investors have made money and the honest companies are paying dividends. The field has subsided from the condition of frenzied excitement and "wildcat" speculation which marked the first days of its discovery, and has settled down to one of systematic business organization and production. Pipe lines, refineries and tank cars are now in great abundance. The statistics are not available for the production of the whole field, but the following, taken from the "Engineering and Mining Journal" for Feb. 7, 1903, shows the production of Spindle Top Hill for 1902:

Beaumont Oil Production in 1902.—Shipments, January 1 to June 30, 3,768,000 bbls.; July, 850,000; August, 915,000; September, 828,815; October, 916,979; November, 844,791; December, 1,004,569; total shipments 1902, 9,128,154 bbls.; local consumption, 500,000 bbls.; waste, 1902, 400,000 bbls. Increased oil in store over December 31, 6,105,000 bbls.; total production 1902, 16,133,154 bbls.
Total production in 1901, 4,190,000 bbls.
Total production of field, 20,323,154 bbls.
Iron tankage completed, 7,280,000 bbls.; earth reservoirs completed, 57,100,000 bbls.; total tankage, 14,380,000 bbls.
Oil in store Dec. 31, 1902, 7,105,000 bbls.; prices for crude in 1902 varied from 2 cts. to 50 cts. per bbl. in tanks.

AN AUTOMATIC LOOM DEVICE has been invented by James Cowburn, of England, according to the Manchester "Guardian." It is applicable to all kinds of existing one-shuttle looms, and may approach in importance the fly-shuttle itself. By its use the careless or preoccupied weaver is unable to put in two shuttles and so cause a smashup. It is claimed that the device effects a 10% increase in production and a 10% economy in cost of operation. No clear description is given of the "shuttle-stop motion," as the device is termed, but it is said to be exceedingly simple and so compact that an ordinary hat will hold all the parts.

INDEFINITE REPORTS OF TYPHOID FEVER at Leland Stanford University, and at Palo Alto, Cal., where the university is located, have been received.

*A Postscript presented Feb. 14, 1903, to the American Institute of Mining Engineers.
†Geologist, U. S. Geol. Survey, Washington, D. C.
‡The paper referred to will be found in Engineering News, Oct. 2, 1902.

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ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page XXIV-XXIX. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.

In connection with our recent remarks regarding the Mississippi levee system and our statement that this year's great flood, the highest on record, has furnished new proof of the value of the levee system, we note with interest an interview with Major B. M. Harrod, Past-President of the American Society of Civil Engineers and a member of the Mississippi River Commission. The Commission followed the crest of the flood wave down the river from St. Louis to New Orleans, and Major Harrod is quoted as follows in the New Orleans "Times-Democrat" of April 25:

> The result of our trip proves to me conclusively that levee construction should be encouraged; that it has been the levees that have saved the country. This statement is best substantiated by a comparison of facts. Our previous high water stage was in 1897. During that spring there were 42 crevasses between Cairo and the mouth of Red River. Millions of acres were inundated. This year, with the river from 1 ft. to 2¼ ft. higher than it was in 1897, we find five crevasses only—the area of land overflowed proportionately less. To my mind, the result is the absolute vindication of levees; and yet they are not at all up to the standard recommended by the Mississippi River Commission.
>
> The work done, the improvement made since 1897, have hundreds of times paid for the labor.
>
> On our trip we found that levees that had been constructed properly resisted the most violent attacks of the water. Strong levees are necessary for the protection of our country. And I do not question the fact that, in time, we will have them.
>
> Most careful investigation made by the commission shows no evidence at all that the bed of the river has been raised or the capacity of the channel reduced.

The committee which has been at work preparing a revised constitution for the American Society of Mechanical Engineers has completed its work and the draft of the proposed new constitution has been distributed to the members, who will have a chance to discuss and amend it at the Saratoga meeting next month prior to its submission to letter ballot for final adoption. The committee is to be congratulated on the result of its labors. The draft they have submitted may not satisfy every member in every particular. Such a result, indeed, could hardly be expected. It will be accepted by the bulk of the membership we believe, however, without question; and we do not look for any radical changes to be brought forward at Saratoga.

The committee has wisely left the annual membership dues on their old basis. The only change is in the dues of Juniors, who must pay the same as a member or Associate after being six years in the Junior grade.

A novel scheme has been adopted for life membership dues. Instead of making this a fixed sum, the payment for a life membership is now fixed at an amount sufficient to purchase for a person of the member's age an annuity of $15 per annum. This will give an incentive to the older members of the Society to take life memberships that has hitherto been lacking.

A very notable change is in the number of "black-balls" required to defeat a candidate for membership. This is now set at 2% of the votes cast, in place of the seven negative votes fixed in the present Rules. Besides this, if a candidate is rejected, his endorsers may present to the Council a written request for a second ballot. By a three-fourths vote of the Council a second ballot may be ordered, and on this second ballot, 4% of the votes cast must be negative ballots to reject the candidate. This provision for reconsideration is a new feature, copied from the recent practice in the American Society of Civil Engineers. In that society, however, 10% of the votes must be negative on the second ballot to defeat a candidate.

A national (German) automobile exhibition was held in Berlin during the month of March. Over a hundred builders of motor-vehicles, nearly all German, showed machines, and there was a large attendance of visitors, principally "automobile enthusiasts," who were permitted, under relaxed police regulations, to speed over the boulevards of the city in defiance of the legal speed limit. In a recent issue of the "Advance Sheets of Consular Reports," Consul-General F. H. Mason describes this exhibition and says:

> The distinctive feature of the exposition of this year . . . is the uniformity with which the latest and best work of all the great German builders conforms to two or three standard types.
>
> Last year, and especially two years ago, . . . there was a nearly even number of electrical and gasoline motors, with steam as a promising third in the race. This year nine-tenths of all the vehicles exhibited have hydrocarbon motors.

He also implies that there was practically no representation of freight-carrying vehicles.

It is noteworthy that this is exactly the comment which we made on the automobile exhibition held in New York city last January. In our issue of Jan. 29 we remarked on the practical absence of freight-carrying vehicles, on the general and strong preference for the touring-car type of passenger vehicle, and on the present ascendancy of the gasoline engine as the motive power for automobiles. We gather from Consul Mason's comments on the Berlin exhibition that these conditions are not confined to America, but exist in Europe as well.

The account of the construction of the Chaudiere Falls water power plant, which we print in this issue, contains among numerous other interesting features particulars of a clever scheme for laying masonry and concrete in severely cold weather, in such a manner that no question as to the quality of the work can arise. The scheme simply consisted in covering the work with a light wooden house, inside which the temperature was kept above the freezing point by stoves.

It is true that the character of the work made this scheme particularly easy to carry out, and that there are many classes of structures to which the plan could not well be applied. On the other hand, there are a good many cases, such as large foundations, where temporary enclosures could be erected with very little difficulty and would enable concrete and masonry to be laid with very little more expense in winter than in summer, and with equal certainty of a satisfactory quality of work.

In connection with the article on the Chaudiere Falls power plant, we venture also to call particular attention to the excellence of the illustrations which accompany it, and to the completeness with which the details of the work are shown. We do this not for the purpose of praising our own work, but because we think it possible that some of our more recent subscribers may not be aware of the practical usefulness of such illustrations of engineering work as are presented in this journal.

It has become so common in technical and trade journals to use all sorts of material for illustrations from sources reliable and unreliable that many engineers hesitate to use a published drawing as a guide in designing similar work. There is particular reason for this distrust where cuts are made by the wax process, in which the lines of an intricate machine, for example, may be drawn by men wholly unfamiliar with the machine they are attempting to portray, and where there is always a chance of error in figures and letters in copying from the original.

For this and other reasons, we have never used the so-called wax process engravings in Engineering News. Instead all our line cuts are photo-engraved from the originals. Taking the case of the Chaudiere Falls illustrations as an example, we were furnished, through the courtesy of the Resident Engineer of the works, Mr. C. H. Hollingsworth, with a complete set of blue-prints from the working drawings. From these prints we selected those showing the details of most interest and in our own drafting department tracings were made from these prints, taking care to show clearly the features, dimensions, etc., of most importance and to bring out the actual structure by careful shading in a manner seldom done in ordinary working drawings. These tracings, made with lines and lettering heavy enough to suit the proposed scale of reduction, were then taken by the engraver and by a photographic process a cut was produced ready for the printer which was an absolutely correct fac-simile of the original tracing.

By this process the chances of error are reduced to a minimum and the engineer can use the published engraving for a guide with practically the same confidence and with vastly more convenience than he could the original drawing or blue-print.

Of course what has been said above applies only to cuts prepared from working drawings in our own drafting room, which constitute, however, the bulk of the illustrations which we publish. In the case of articles which we reprint from the proceedings of engineering societies or from other journals, we use, of course, such matter as is available; and any errors in the original will exist also in our reproduction.

What we have just said will be nothing new, doubtless, to a large proportion of our subscribers who have been accustomed for many years to make frequent use of the drawings published in this journal. We trust it may be a serviceable hint, however, to some of our younger readers, who may not have appreciated the accuracy and reliability of the drawings which we present and the advisability of permanently preserving the files of the journal for reference.

A UNION BUILDING FOR AMERICAN ENGINEERING SOCIETIES IN NEW YORK CITY.

It gives us the greatest pleasure to give to our readers this week the news that a great engineering building for the national engineering societies of America has been made possible through the wise generosity of Mr. Andrew Carnegie, and that plans for securing the effective coöperation of the four great national engineering societies and the prosperous Engineers' Club of New York city in the acceptance and utilization of this magnificent gift are already far advanced.

As our readers are aware, the plan to build a great engineering society building in New York city, representative of the entire engineering profession, has been much discussed during the past half-dozen years; but the financing of such a huge undertaking presented so many difficulties that the plan has never reached a more advanced stage than mere speculation. Now, however, these difficulties have been swept away at one stroke

and effective coöperation between the different organized branches of the engineering profession, which Engineering News has advocated in season and out of season for many years, is a certainty.

We think it is worth large emphasis that this great gift from Mr. Carnegie comes unsolicited. The engineering societies of America are great educational institutions for the advancement and upbuilding of the profession; but they are not organizations in need of charity. It is because Mr. Carnegie saw and appreciated the great advantage to the engineering profession of the union and coöperation that might be brought about, that he decided to make this great benefaction.

Many of our readers will remember in our report of the anniversary dinner of the Engineers' Club of Philadelphia on Dec. 6 last, the speech of Mr. Chas. F. Scott, President of the American Institute of Electrical Engineers, on the theme of coöperation among engineers. Mr. Scott has been earnestly advocating for some time past coöperation among the four great national engineering societies in the establishment of joint national headquarters in New York city.

At the annual dinner of the American Institute of Electrical Engineers on Feb. 9, Mr. Scott again urgently set forth his ideas on this subject. Mr. Carnegie was one of the guests of honor at this dinner, and was greatly impressed with Mr. Scott's remarks. On the following day he sent for Mr. Scott and Mr. Calvin W. Rice, a director of the Electrical Engineers and a member of the Mechanical Engineers' Society. Mr. Carnegie told these gentlemen that he had been greatly interested in the suggestion of a common building for the various societies, and he made detailed inquiry respecting the work and the financial status of the various organizations. We quote further as follows from a letter written by Messrs. Scott and Rice on Feb. 11:

Mr. Carnegie asked what plans, or definite suggestions, we had in mind. We replied that so far the scheme of an Engineering Building had been discussed by individuals, but that no official or concerted action had been taken. We could simply outline a policy—not a specific plan. We said that our ideas would be met by an adequate building on 40th St. to accommodate the National Engineering Societies, to provide headquarters and meeting places for other engineering bodies and to provide for the Engineers' Club. Each body should have such individual rooms as would meet its requirements, and there should be suitable assembly halls and the like, to be used in common. The placing of the technical libraries of the several societies in one building, near the new public library, appealed to Mr. Carnegie.

He wanted us to ascertain what the land would cost; but, later, when he had indicated about what the societies are paying in rent, and the value of the property held by some of them, he said: "Why, you are able to support a building if you had one"; and a little later, he said: "Why, if you can provide the ground I will put up the building."

Mr. Carnegie asked that we take up the matter confidentially with others interested, and that we call again with a few other gentlemen as soon as we have a plan to submit.

On the afternoon of Feb. 11, a meeting was held at the Engineers' Club in New York city, to which Messrs. Scott and Rice presented a report of their interview with Mr. Carnegie. There were present at this meeting the following gentlemen:

Alfred M. Noble, President, and Chas Warren Hunt, Secretary, American Society of Civil Engineers. Chas. Kirchhoff, Past-President, American Institute of Mining Engineers. Prof. F. R. Hutton, Secretary, and W. H. Wiley, Treasurer, American Society of Mechanical Engineers. Chas. F. Scott, President, and C. W. Rice, Director, American Institute of Electrical Engineers. John C. Kafer, President; John Thompson, Past-President, and Wm. A. Redding, Chairman House Committee of the Engineers' Club. Last, but not least, John Fritz, member and past officer of more engineering societies than we can take space to name, and honored in all.

After thorough and favorable discussion of the project, the matter was placed in the hands of a committee consisting chiefly of gentlemen connected with the Engineers' Realty Co., an organization which has in hand the building enterprise of the Engineers' Club.

On Feb. 14, Messrs. Fritz, Thomson, Kafer, Redding, Scott and Rice again called on Mr. Carnegie and the result of the interview is best expressed in the following letter, which we venture to call:

A Valentine to the American Engineering Profession.

2 East 91st St., New York, Feb. 14, 1903.

Gentlemen of the American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Mining Engineers, American Institute of Electrical Engineers, and the Engineers' Club:

IT WILL GIVE ME GREAT PLEASURE TO GIVE, SAY, ONE MILLION DOLLARS TO ERECT A SUITABLE UNION BUILDING FOR YOU ALL, AS THE SAME MAY BE NEEDED.

WITH BEST WISHES, TRULY YOURS,

ANDREW CARNEGIE.

To carry out the plan, steps were at once taken to secure options on the necessary land, and the work of doing this was entrusted to Mr. Kafer. This was accomplished, and the following letter from Mr. Carnegie's cashier shows that the funds necessary for this have been already furnished by Mr. Carnegie:

To Mr. John C. Kafer, President, The Engineers' Club, 374 Fifth Avenue, New York.

Dear Mr. Kafer:

I have yours of the 11th instant and in reply would say that Mr. Carnegie has authorized me to pay for options on property for new Engineering Building, also to furnish the funds for the purchase of property to be used for site for the building. I am, therefore, in position to pay the amount required to hold the property referred to in your letter, and to pay for the lots if they be secured.

Yours very truly, R. A. Franks.

Hoboken, N. J., April 13, 1903.

On April 30, a dinner was held at the Engineers' Club, at which were present Mr. Jas. M. Dodge, President Am. Soc. C. E., and Mr. E. E. Olcott, President Am. Inst. M. E., besides most of those who took part in the conference previously mentioned. At this meeting a formal statement was presented respecting the project by Mr. Scott, on behalf of the committee. We print this statement nearly in full as follows:

Gentlemen:—You have been invited to this meeting in order that there may be formally transmitted to the representatives of the several societies interested, the proposition of Mr. Andrew Carnegie to erect a Union Engineering Building, and to receive the report that options on certain lots have been acquired, as was advised by Mr. Carnegie before a general statement of the plans should be announced.

The reasons which prompted Mr. Carnegie to make his generous contribution may be judged from some of his remarks in an address before one of the societies on the evening prior to his taking up the matter with representatives of that society. Mr. Carnegie said:

I have often taken occasion to say—and I have known both lands well—that the American men, this body of electrical engineers for instance are the most co-operative men, I believe, that exist to-day. . . . I think there is a harmonizing feature about them which counts for everything in the progress of any great movement, political, social or scientific. And it is institutions like this of the Electrical Engineers which do so much: you cannot overestimate the influence such organizations exert.

The committee to whom Mr. Carnegie entrusted the first steps in the present undertaking, have appreciated the responsibility which has rested upon them, and have been imbued with the extent and the far-reaching importance of their work. Never has there been such a handsome recognition of the standing and worth of the engineering profession as that which is accorded in this gift; and never has such an opportunity been afforded for engineers to elevate the dignity of their profession and the standard of their work. And never, it may be added, has there been such a vast field of engineering opportunity as now lies before the American engineer. Our material prosperity and industrial pre-eminence are the testimonials of what American engineering has accomplished. Mr. Carnegie's gift to the National Engineering Societies marks the beginning of a new era in American engineering.

The value of this gift to the engineering profession has been eloquently set forth in the accompanying statement, prepared, at the request of the committee, by the venerable man whom the four Engineering Societies have so recently honored in the founding of a medal bearing his name—Mr. John Fritz.

LOCATION.—The site selected for the Union Engineering Building, for the Engineers' Club and the National Societies on 40th and 39th Sts., between 5th and 6th Aves., is the ideal spot in America for such a building. However widely the membership and the interests of a society may be scattered, New York city must be recognized as the engineering center of the country. The location selected is in the very heart of the coming business center of New York. In the past, the means of travel from Brooklyn on the one hand, and from the west on the other hand have centered by bridge and by ferry at the lower extremity of Manhattan Island; hence the congestion of business in that section. In common with the general northward movement the transportation facilities are changing. The new Pennsylvania terminal with tunnels to Brooklyn and to the west, the new station of the New York Central system, the facilities afforded by the Rapid Transit Subway all point to the vicinity of 40th St. as the coming transportation and business center of the metropolis. It is also the center of the hotel district.

OTHER SOCIETIES.—The four general Engineering Societies named by Mr. Carnegie are but a part of the engineering societies which are to be benefited by a Union Engineering Building. There are numerous societies, many of them strong and vigorous, whose membership contains many of the members of the general societies, but whose fields of activity are specialized in their scope. The work of these societies is of a high order, and taken in the aggregate it is a most important part of American engineering. Definite permanent headquarters and accommodations in the same building with those of other societies will be advantageous to the societies themselves, and will be of great convenience to their members.

FUNCTIONS OF A BUILDING.—Some of the uses and advantages of a Union Engineering Building may be indicated in a general way without entering upon details.

A large assembly hall will be available for lectures and for the holding of general conventions of engineering societies.

A number of smaller halls will accommodate smaller audiences and will be suitable for monthly meetings of societies and for sectional or supplemental meetings at the time of conventions.

The libraries of the several engineering societies placed in adjacent alcoves or rooms will constitute a magnificent engineering library. Economies will be effected, as many books need not be duplicated which would be necessary if the libraries were separate, and there may be reduced cost for administration. The several libraries may have a common index. *Moreover, the Union Engineering Library will be adjacent to the new building of the New York Public Library, 40th and 42d Sts.*

Rooms may be available for reading and writing. The building itself may become a gallery of portraits of eminent engineers and illustrations of engineering works.

Accommodations for the administrative offices of the several engineering societies may be arranged to suit their various needs. Facilities for the officers, boards of direction, committees, as well as for the mailing, and possibly the printing of transactions may be afforded.

Facilities may be arranged for the serving of luncheons or dinners at the time of conventions or meetings and for the holding of formal dinners and banquets. A common cuisine may serve the Engineers' Club and the engineering societies.

PLAN OF ORGANIZATION.—A plan of organization and a general statement of the legal phases of the situation, are set forth in the accompanying statement, by William A. Redding, Esq., Chairman of the House Committee of the Engineers' Club.

IN CONCLUSION.—Mr. Fritz's statement refers to some early attempts at co-operation between the engineering societies. The Transactions of the various societies as well as addresses by engineers and communications in the technical press show that there has been a growing sentiment among engineers looking to harmonious relations which should be mutually beneficial. Some of the ideas have contemplated an actual merger of the various societies on the more recently developed lines of commercial consolidations; the resulting organization to be operated in effect as a unit. In view of recent engineering developments it is probably just as well that such a plan was not carried out. At other times plans have been proposed, most excellent in themselves, based upon high ideals, but they came to nothing as they found no material support. The construction of the present house of the American Society of Civil Engineers has acted as a healthy stimulus to others, by demonstrating the advantages and indicating the possibilities of a camping together, or focussing, of forces in the future. Again, the signal success of the Engineers' Club in bringing together professional men of various specialties, and the splendid feeling which has been developed, world-wide, among engineers and industrial captains in the founding of the John Fritz Medal, have been potent factors in the development of a condition which seem to make the time ripe to meet the present opportunity.

The idea of Mr. Carnegie is significant in its very breadth. He has not imposed restrictions nor introduced details. In a single sentence he has presented a great opportunity, and places confidence in engineers that they will adequately meet it. The present is the time to expand; to construct a magnificent ideal; to picture what

should be done, and to devise how it may be accomplished. Let us first develop our grand ideal. There are plans to be arranged and details, perhaps perplexing, are to be worked out. Engineers are now called to work out for themselves a problem similar to those which they are continually solving for others.

To us is committed a great trust on behalf of American Engineering. The real question to be decided is not whether we will accept it, but it is whether we can take the responsibility of refusing to administer it.

LETTER OF JOHN FRITZ.

Bethlehem, Pa., April 29, 1903.

My Dear Mr. Scott: Yours of the 25th asking for a statement, on general lines, expressing my views regarding the proposed project of housing the Civil, Mining, Mechanical and Electrical Engineers, all in one building, is at hand.

The object of our meeting to-night is not new to me, but it is most interesting; for some years before the death of our lamented Holley, he and I had many talks on the subject that has called us together. At that time, the most we hoped to accomplish was to devise some means that would bring the engineering societies in closer touch with each other. We had a scheme which we thought was practicable, and would at least in a measure accomplish the purpose; but there were difficulties in the way and the project was quietly laid aside.

About that time, too, Mr. Andrew Carnegie was laying the foundation for his stupendous fortune, and now in his great generosity, and in recognition of the merit of the engineer, and mindful of the assistance he received from them during his most remarkably successful career, he has so nobly offered to give the money to purchase the lot and erect a building that will accommodate the four great engineering societies, and the Engineers' Club, separately; which will be a monument to the engineering profession and will let the world know that there is one man who knows and acknowledges their work and worth.

When Mr. Holley and I talked over some plans to bring the engineers closer together, the wildest flight of our imagination could not have conceived the idea of such a magnificent gift as is now presented to us, for the fulfillment of the object that was then so near our hearts.

There is something so beautiful and encouraging to the young men to know that the donor was at that time one of us, the same as the young men of to-day, who was struggling for recognition amongst the business men of the country, the same as you are for place in the line of your profession. And I beg to say that, in my humble opinion, the occupation of the engineer is one of the grandest, most useful and far reaching that falls to the lot of man to pursue; and I know of no calling that requires more thoughtful and careful study than that which inspires and pervades the profession; nor is there any society or class of people that the world is so much indebted to as the engineer.

I shall now treat them as one family and recognize the beneficence of their united efforts. The value of their genius and influence and what they have accomplished cannot be estimated or restricted to any one country. They are only bound by the law of progress; which means that each triumph of their genius inspires them to higher and grander accomplishments. I ask who built our great system of railroads, who designed and built the ships of our honored navy, and thousands of other works of merit that could be mentioned? The answer is the engineer. But no one society of engineers can claim that its members did it all; for it has all been accomplished by their united efforts. I most ardently hope they may still become more closely associated, both on social and on engineering lines.

The societies are so interdependent, and overlap each other to such an extent, that to me it is most surprisingly strange that the efforts which have been made before this time to bring them in closer contact with each other, have not been successful.

It has been my fortune to have good friends in the various societies; and we were, at all times, ready and willing and happy to exchange ideas with each other; and I am absolutely certain that we all profited by it, and the country at large received the benefit.

When I first went to work in the rolling mill and would go near the roll turner, he would take up his templates and put them in his pocket. I am happy to say that the people are becoming more tolerant; that the conditions of the country have greatly changed and we must be prepared to meet them. What is now wanted is well-informed, liberal, broad-minded and many-sided men; and I am a firm believer, all other things being equal, that every man should know something of everything and everything of something.

Now, the only way that I can see to obtain this knowledge is to get close together. By pursuing this method, all parties will be benefited and they will obtain certain practical knowledge and advantages that cannot be otherwise obtained. And I know of no plan by which this can be so well accomplished as that proposed, where all the specialists can conveniently meet each other and at the same time have access, under proper rules, to the various libraries. This would be the college of colleges.

The Electrical Institute, though the youngest, has great possibilities before it, and may be the means through which the older societies can be brought together. The members of this society are young and pliable; who are dealing with an element that requires them to be ever on the alert, and who well know the value of cumulative knowledge.

As there has been nothing said regarding the Marine and Naval Engineers, I have made no specific allusion to them; but I would like to see them all included, and also both the physical and analytical chemists.

Finally, it is the young men who will derive the greatest advantage by the adoption of the proposed plan. Should this plan fail, and were I a young man, knowing what I now do on the subject, it would be one of the objects of my life to devise some means by which the younger members of our profession could be brought into closer unity.

Sincerely hoping for complete success, I am,

Yours most truly, John Fritz.

LETTER FROM MR. WM. A. REDDING RELATING TO THE LEGAL STATUS OF THE PROJECT.

Potter Building, 38 Park Row,
New York, May 1, 1903.

Charles F. Scott, Esq., Pittsburg, Pa.

Dear Sir:—Engineers's Realty Company, a corporation organized under the laws of New York, has recently purchased the property on the south side of 40th St., about 420 ft. west of Fifth Ave., in this city, 50 ft. wide by nearly 100 ft. deep, as a site for a new club house for The Engineers's Club of this city.

Written options have been recently acquired* in the name of R. A. Franks, Esq., who represents Andrew Carnegie, Esq., to purchase before July 1, 1903, five contiguous properties on the north side of 39th St., west of Fifth Ave., in this city, which are immediately in rear of the above mentioned property on 40th St., and the aggregate width of which is 125 ft., and the depth of which is nearly 100 ft. These five contiguous properties are to be purchased as a site for a suitable building to be occupied by The American Society of Civil Engineers, The American Society of Mechanical Engineers, The American Institute of Electric Engineers and the American Institute of Mining Engineers and such other societies of engineers as shall be determined upon.

You have requested me to set forth in a letter to you my views as to how the titles to all of these properties should be held to best accomplish the objects contemplated and as to how the cost of the purchase of all of these properties should be apportioned between the Engineers' Club, the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Institute of Mining Engineers, and as to how the character and arrangement of the building to be erected on both sites should be determined and as to how the apportionment of the building to be erected on the site on 39th St. among the various societies of engineers should be determined, and complying with this request I now submit for consideration suggestions as follows:

AS TO HOW THE TITLES SHOULD BE HELD.

The Engineers' Club should purchase from Engineers' Realty Co. the property on 40th St., subject to the mortgage for $110,000, now secured thereon, and in payment therefor should give to the Engineers' Realty Co. 1,150 bonds of the par value of $100 each executed by the Club and to be payable in 20 years from the date thereof and to bear interest at the rate of 4% per annum payable semi-annually; and the Club should have the right and option to pay off all or any of these bonds at any time before the expiration of the 20 years; and all of these bonds should be secured by a second mortgage to be given by the club to a trustee upon said property on 40th St.

Engineers' Realty Co. should distribute these 1,150 bonds among its stockholders by giving to each stockholder one bond for each share of its capital stock owned by such stockholder; and upon the completion of such distribution of these bonds this company should be wound up and dissolved.

The American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Institute of Mining Engineers should purchase the five contiguous properties on 39th St. and accept a conveyance of them in fee simple to these four national societies of engineers as tenants in common, share and share alike; and the cost of the purchase of these five contiguous properties on 39th St. should be paid by these four national societies of engineers share and share alike.

Each of these four national societies of engineers might pay its proportion of the cost of purchase of these five contiguous properties on 39th St., in cash, or it might execute and give a bond and mortgage secured upon its interest in these properties for the payment of its proportion of the cost of purchase, to be made payable at such period of time as should be satisfactory to it and to bear interest at the rate of four per cent. per annum payable semi-annually.

If these four national societies of engineers should own the whole of the site on 39th St., together with the building to be erected thereon as tenants in common, share and share alike, as above suggested, and should use such building exclusively for carrying out the purposes for which they have been organized and without deriving any profit by way of rentals or otherwise therefrom, then the whole of the site on 39th St. and the building to be erected thereon would be exempt from taxation, which would result in a saving of at least $10,000 per annum.

AS TO HOW THE CHARACTER AND ARRANGEMENT OF THE BUILDINGS SHOULD BE DETERMINED.

There should be a joint committee, composed of the president and two other members of each of the organizations that shall unite in accepting the gift of $1,000,000 from Andrew Carnegie, Esq., and this joint committee should have power to determine by the affirmative vote of at least two-thirds of all the members thereof the character and arrangement of the buildings to be erected on the site on 39th St., and on the site on 40th St., and should also have power to obtain from competent architects plans and specifications for the erection of such buildings, and to approve by the affirmative vote of at least two-thirds of all the members thereof of the plans and specifications for the erection of such buildings, and should also have power to make and enter into such contracts as shall be approved and authoized by the affirmative vote of at least two-thirds of all the members of such committee for the erection of such buildings.

The vesting in such joint committee of these powers would avoid great diversity of opinion and much controversy that would arise if these matters should have to be submitted to each organization for approval.

AS TO HOW THE APPORTIONMENT OF THE BUILDINGS SHOULD BE DETERMINED.

The building to be erected on the site on 40th St. should of course be occupied exclusively by The Engineers' Club.

The joint committee above suggested should have power to determine by the affirmative vote of at least two-thirds of all the members thereof what portion of the building to be erected on the site on 39th St. should be occupied by each of the four national societies of engineers above-named that shall unite in accepting the gift of $1,000,000 from Andrew Carnegie, Esq., and what portion of that building should be reserved for the occupancy by other societies of engineers that should be permitted to locate therein.

This joint committee should also have power to determine by the affirmative vote of at least two-thirds of all the members thereof what societies of engineers, other than the four national societies of engineers above named should be permitted to occupy portions of the building to be erected on the site on 39th St.

The societies of engineers other than the four national societies of engineers above named as shall be permitted to occupy portions of the building to be erected on the site on 39th St. should not be charged any rentals therefor. If any rentals should be charged, the property to a partial extent would undoubtedly be liable to taxation.

All expenses incurred from time to time for the care and maintenance of that building including interest on mortgages should be paid by each society of engineers that shall occupy the building on 39th St. in the proportion that its floor space shall bear to the aggregate floor space that shall be occupied by all the societies of engineers.

The libraries of the various societies of engineers that shall occupy the building to be erected on the site on 39th St. should be contained in one large room to be provided in that building for such purpose, but the library of each society of engineers should be kept separate and independent from the libraries of the other societies of engineers, and each society of engineers should have its own attendants in charge of its library and under its exclusive control.

The Engineers' Club and all societies of engineers that shall occupy the building to be erected on the site on 39th St. should have the right to use all of the auditoriums in that building free of charge.

In order to have a desirable governing body to prescribe rules and regulations for the use of the libraries and auditoriums and particularly to fix the dates on which the auditoriums may be used by the various organizations, there should be a committee composed of three members elected annually by the Board of Trustees of the Engineers' Club and three members elected annually by the council of each of such of the four national societies of engineers as shall occupy the building to be erected on the site on 39th St.; and this committee shall have full power to prescribe rules and regulations for the use of the libraries and auditoriums and to fix the dates when the auditoriums may be used by the various organizations.

The independence and integrity of each organization should be thoroughly preserved and nothing should be done to affect or interfere with the same.

ACTION TO BE TAKEN.

The Engineers' Club and the four national societies of engineers above named should vote upon suitable resolutions sufficient to bring these five organizations into this enterprise.

Following this, Mr. Redding submitted a form of resolutions suitable for adoption by each organization to carry out the plan above set forth:

At the meeting on April 30 above noted a meet-

*At a cost aggregating $50,000.

ing was called of the governing bodies of each of the societies interested, to be held at the house of the American Society of Civil Engineers on May 7, to take further formal action respecting the project.

Allusion has been made at several places in the above statements to the possibility that some of the societies might refuse to coöperate with the others in the acceptance of Mr. Carnegie's great gift. It seems to us incomprehensible that such a thing could occur. Of the four national societies two, the Mining and the Electrical engineers have their headquarters in rented offices which furnish merely space for the Secretary's staff. The Mechanical Engineers have a house which has become inadequate for their needs. The Civil Engineers alone possess an adequate building; but it is so inconveniently located in comparison with the site on 40th St. that it would well repay the society to remove to the new location on that account alone. The convenience of the new site to the New York public library, the Rapid Transit road, and the great new terminals of the Pennsylvania and New York Central railways make it an ideal site for an engineering headquarters.

As to the financial outlay required to secure the necessary site we judge that the Mining and Electrical engineers' societies could furnish this without difficulty. The latter society already has a building fund of considerable amount. The Mechanical and the Civil Engineers could dispose of their present buildings, and after paying their share toward the new site would have a large surplus, which could well be treated as an endowment fund and the income applied to extending the society's work in the increase of the library, the conduct of research by committees, or in such other directions as might be deemed advisable.

The influence and value of such an engineering center to the entire profession is too obvious to call for comment.

LETTERS TO THE EDITOR.

Calculating Masonry Arches.

Sir: The writer has built many stone arches, and last year planned one that was more difficult than usual. On that occasion he investigated the matter of designing arches, and found the methods indicated by our standard authorities, such as Weisbach, Rankine, Howe, Baker, Trautwine, very unsatisfactory. As the result of his investigations he developed general equations which he thinks solve the arch problem, and also make it possible to deal with several other difficult engineering questions.

My results are as follows: The linear arch is to be taken as the basis of the arch design, with the following equation:

$$y = \frac{s^2}{16\,h}\left[\frac{4\,hx}{e^{\frac{s^2}{}} - e^{-\frac{s^2}{}}} - \frac{4\,hx}{s^2}\right]^2$$

The radius of curvature of this curve is

$$\rho = \frac{s^2}{32\,h}\left[\frac{8\,hx}{e^{\frac{s^2}{}} + e^{-\frac{s^2}{}}} - \frac{8\,hx}{s^2}\right]^2$$

the origin of co-ordinates being taken at the vertex of the curve, i. e., at the crown of the arch. The radius at the crown is found from the preceding equation to be

$$\rho_o = \frac{s^2}{8\,h}.$$

The equation for the crown thrust per unit length of arch is

$$T = \left[\frac{s^2}{8\,h}\right]^2 w.$$

The terms used in the preceding equations have the following meanings:

s = span of arch;
h = rise of arch;
w = weight of a cubic unit of the arch and its load;
e = base of natural logarithms.

The above equation for thrust assumes that the load has a depth over the crown equal to ρ_o, the radius of curvature at the crown. If the load is of less depth, the thrust is to be correspondingly reduced. Thus, in the arch described in Engineering News of May 8, 1902, if the depth of load were 3 ft., the thrust at the crown would be, for each lineal foot of arch,

$$T = \left[\frac{s^2}{8\,h}\right]^2 w \frac{3}{\rho_o} = \frac{30^4 \times 150 \times 3}{64 \times 3.5 \times 3.5 \times 32.14}$$

= 14,470 lbs., the value of ρ_o being 32.14 in this case.

In the case of a tunnel the load above the height ρ_o from the crown does not increase the crown thrust.

As may have been already noted, the first three equations given, those for the linear arch and for its radius of curvature, are equally applicable to structures wholly in tension. Yours truly, C. H. Wallace.

St. Helena, Napa Co., Cal., April 5, 1903.

What is American Hydraulic Cement?

Sir: We would be ever so much obliged if you will send us your interpretation of the term "best quality of American Hydraulic Cement." We have a contract here for considerable masonry in which that is the only term used in specifying the cement. When we bid on the work we were under the impression and bid with the understanding that that meant the natural or Rosendale cement. The engineer undertakes to claim now that this term means Portland cement. We have never before in our experience on public works found a specification that called for Portland cement which did not state Portland in the body of the contract, but have several times found the natural or Rosendale cements mentioned as hydraulic cements.

F. C. C.

April 28, 1903.

(If the contract had been written 20 years ago there would have been no question that the thing specified was natural cement and not Portland. At the present day there is equally no question that the "best quality of hydraulic cement" of American manufacture is Portland cement. The case really turns on what the word "American" means. Does it signify the place where the cement is made or is it a case of the use of the old term for what is now commonly called natural or Rosendale cement? We know of no one who could settle the matter except the writer of the specification; but unless he could show specific authority for his discrimination against cement of foreign manufacture, it would seem a fair presumption that what he really intended to specify was natural cement and not Portland.

Incidentally we may remark that to specify the "best quality" of cement or of any other material, simply betrays the ignorance and incompetence of the writer of the specifications. Only the frequent use of such ambiguous and meaningless terms in specifications gives them a shadow of excuse. Nobody is wise enough to say that a given sample of cement or lumber or steel or any other material is so good that a better could not be found. What the clause actually means is that the material must be good enough to satisfy the engineer in charge, and it would be better to frankly say so and let the contractor know at the outset that he is up against an uncertainty.

Of course, wherever this is done the specification is really not a specification; it pretends to say what the contractor must supply and actually does nothing of the sort.

The correct and fair way to do is to tell the contractor just what quality of material he will be required to furnish. He can then know what to count on and is not obliged to add to his bid so large a percentage for uncertainties.—Ed.)

Capacities of Plate Girders.

Sir: In your issue of April 16 is given a table of capacities of plate girders. The article says: "The longer leg of angles is perpendicular to the web." At first glance, one would think an error had been made and that the author of the table meant to say "the shorter leg of the angles is perpendicular to the web," but the column of effective depths clearly indicates that no typographical error had been made.

Will Mr. Batchelder kindly tell us how he develops the strength of the 5 × 3½-in. and 6 × 4-in. angle with a single row of rivets in the flange angles. Take for example the girder with 30 × ⅜-in. web and 6 × 4 × ¾-in. flange angles. The stress given is 123,800 lbs.; the value of a shop rivet, according to Cooper's specifications, is 3,936 lbs., which means 32 rivets required to develop the strength of the flange which, in turn, means less than 1¾ ins. c. to c. of rivets.

Most bridge companies have such tables as that given by Mr. Batchelder, but I doubt if anybody ever used a single row of rivets in a floor beam flange for a railway bridge with modern loads. Yours truly,

Milwaukee, Wis., April 18, 1903. Subscriber.

(A similar criticism on Mr. Batchelder's table has reached us from Mr. S. W. Bowen, of St. Louis. Proof of the above letter was sent to Mr. Batchelder, and we append his reply.—Ed.)

Sir: Perhaps a word of explanation in regard to the tables is necessary. While they were primarily intended for use in connection with railroad bridge work, I also wished to make them complete enough to admit of their use in connection with highway bridge work or building work, by adding to the capacities given a proper percentage to cover the difference in unit stresses. The working stress, 10,000 lbs. per sq. in., used in computing the tables, makes this an easy matter. "Subscriber" can easily convince himself by trial that in building work, at least, there are many probable cases of concentrated loading, that would develop the full strength of the section, chosen by him for example, and yet not require a minimum rivet spacing of less than 2¾ ins., which is three diameters of a ⅞-in. rivet. Because the particular section, chosen by "Subscriber" for criticism, is one of the 72 given in the tables, he need not feel obliged to use it, when his professional judgment would indicate that a section with 6 × 6-in. angles should be used.

In regard to "Subscriber's" final statement that he doubts if anybody ever used a single row of rivets in a floor-beam flange for "modern loads," I can say that I know of at least one bridge built by a Milwaukee firm, designed by them for Cooper's E 45 loading and erected in the winter of 1902-3, which has a single line of rivets in each flange of each of the end floor beams. If he wishes to satisfy himself concerning this, I can furnish him the name of the manufacturer, his contract and drawing numbers.

In using the term modern loads, "Subscriber" evidently has in mind only those roads which have for a standard loading the equivalent of Cooper's E 40 to E 60, forgetting that there are "roads and roads," and that a narrow-gage railway, with its light rolling stock, may be thoroughly modern even if its traffic does not demand locomotives like the big decapods of the Santa Fe or the consolidations on the Pittsburg, Bessemer & Lake Erie.

There is a slight error in connection with the tables as printed. The note "B to b of angles equals thickness of web plus ¼-in," should read, B to b of angles equals depth of web plus ¼-in.

Thanking "Subscriber" for his kindly criticism, and the News for the opportunity of replying, I remain,

Yours truly, F. L. Batchelder.

Houghton, Mich., April 25, 1903.

Sir: The table of "Capacity of Steel Plate Girders" given by Mr. Frank L. Batchelder in Engineering News of April 10 is one which the writer has long had in mind but which he has never found time to compute.

The table as it stands is all one could wish for, if he is using Cooper's Specifications exclusively, but when a man is using half a dozen different specifications in a day, no two of which give the same unit stresses, the table does not prove of so much value. As Mr. Batchelder says that he is open to suggestions the writer begs leave to submit the following:

If the column headed "Bending Moment in ft. lbs." were changed to one giving the Section Modulus (which equals the bending moment in inch pounds divided by the unit stress) the table would be applicable to any specification in which the resisting moment of the web is neglected, and could be used very handily in connection with Carnegie's Hand-book, which gives a similar table for I-beams. Another column could be added giving the Section Modulus for the girders, regarding one-sixth of the web as flange area, which would make the table cover another very large class of specifications.

The Section Modulus where the resisting moment of the web is neglected is:

$$S = Ad,$$

in which

A = net section of one flange,
d = effective depth of the girder.

If one-sixth the web is regarded as flange area, the formula remains the same, but the values of "A" and "d" change to meet the new condition.

The revised table would be just as easy of application to Cooper's Specification as the one given and would have the additional advantage of being equally well adapted to any specification. Yours very truly,

C. T. Morris.

Prin. Asst. Engr., Puget Sound Bridge & Dredging Co.

Seattle, Wash., April 28, 1903.

The Mobile Water-Works Appraisal.

Sir: A leading article of your publication of April 23 last is the "Appraisal of the Mobile Water-Works," and upon which you comment editorially, saying, in part, "there is such a scarcity of information on the appraisal of water and lighting plants about to be purchased by cities that the report of the appraisers of the property of the Bienville Water Supply Co., of Mobile, Ala., printed elsewhere in this issue, possesses much interest and value."

Believing that any additional facts in this connection might be of further interest, I am sending you herewith the communication sent with the report of the appraisers for the consideration of the general council. This communication was prepared by the writer at the request of

the mayor, and deals broadly with the general features of the report of the appraisers and the equities of the situation. Had the recommendation of the mayor been adopted by the council, the details for the appraisement would have come in for searching analysis, at which time the question as to "how the appraisers arrived at 12% on the cost of reproduction, for a water-works plant built 15 years ago," brought up by you editorially, might have come in for a share of the general attention.

The Fourteenth Annual Report of the U. S. Commissioner of Labor, "Water, Gas and Electric Light Plants" (1899), gives as "depreciation" for an average of 52 plants approximating in size the Bienville Supply Co.'s Mobile plant, 2.784% per annum, or about 42% instead of 12% for depreciation during a 15-year period.

Again, since the earning value of the plant also enters into its appraised value, it is interesting to note, from the same source, that the annual revenues of such a plant per 1,000 gallons is placed at about 5¾ cts., instead of 8 cts., and from which the assumed revenue from the plant supplying 4,200,000 gallons would amount to $89,594, instead of $122,640, as appraised; however, it is not the intention of the writer to criticise the appraisement as made, but simply to transmit the communication of the mayor to the council, herein before alluded to.

Respectfully, J. N. Hazlehurst, M. Am. Soc. C. E.,
Ch. Engr. Board of Public Works.

Mobile, Ala., April 25, 1903.

(The communication enclosed by Mr. Hazlehurst bearing the signature of Mr. Walter F. Walsh, Mayor, was dated Jan. 17, 1903, and transmitted the report of the appraisers to the city council. After a general review of the findings of the appraisers, attention is called to the fact that the estimated gross revenue from the water-works after consolidating the competing plants, would average $18 apiece for the 6,787 services connected with the city and the company works. The city plant was built on the assurance of lower rates, Mr. Walsh says, so it is doubtful whether the revenue has not been overestimated, providing the assurances just mentioned are to be made good. The mayor next points out that the water company, after 15 years of service, has some 40 miles of mains and 1,347 consumers, while the city, after two or three years of operation, has 94 miles of mains and 5,440 consumers. The appraisers estimated the value of the physical property of the company at $606,689, and also estimated that if the city bought the private works, consolidated them with its own, and expended $101,202 for meters, the value of the consolidated plant, on a revenue-earning basis, would be $1,405,646. That is, after deducting what the city paid for the plant of the company, and what it paid for meters, from the valuation of the joint works, there would be left only $697,755 to represent the value of the present city plant, with 2½ times the mileage of mains and four times the number of consumers. The mayor says:

> In consideration of the assets expected to be furnished by either partner to the merger plan, upon its face, this apportionment hardly seems an equitable division.

Notwithstanding the opinion just expressed, the mayor endorses the movement toward acquiring the company's property on some just and reasonable basis, without the "appearance of confiscation through the active competition of the municipality." The mayor also expresses regret that the city did not buy out the company as a first move toward municipal ownership. Finally, Mayor Walsh recommended the appointment of a committee of seven members, including five city officials and representatives of two local commercial bodies, to formulate a proposition for presentation to the Bienville Water Supply Co.

For our part, we understand that the appraisers introduced the question of the earning power of the combined plants not so much to indicate the value of the company's property as to show whether the city could finance the undertaking. Otherwise, why was interest on sewer bonds included with a similar item for water bonds?

Obviously there would be a marked difference in fixing the value of the property, according to whether the sale was considered forced or voluntary. Did not the appraisers assume the former condition, but make use of some arguments based on the latter, thus giving rise to apparent contradictions in their reasoning?

As to the depreciation figures in the report mentioned by Mr. Hazlehurst, they may be used to prove anything, since, according to the report itself, they are mere guesses by some water-works official of the proper charge for depreciation, and in some cases run to zero.—Ed.)

Notes and Queries.

A. N., Philadelphia, Pa., asks for the names of makers of gasoline traction engines. The "gasoline" traction engine, shown in Fig. 5 (p. 367) of the article on the St. Louis Exhibition in our issue of April 23, turns out to be an Austin steam traction engine, the smokestack being temporarily removed to allow of repairs to the tubes. We were originally informed that this was a gasoline engine, and the appearance seemed to agree with this, but the Municipal Engineering & Contracting Co., of Chicago, which built the engine and the traveling machine, calls our attention to the mistake.

THE MANUFACTURE AND PROPERTIES OF OLLOW PRESSED STEEL CAR AXLES.*

By Camille Mercader.†

It is a well recognized fact that steel articles manufactured by pressing are, as a rule, superior to articles made by any other method, and the present tendency is to develop this method in every branch of the iron and steel trade, especially as it insures the most economical production of articles needed in considerable quantities and makes them perfectly true and uniform to the templet, permitting interchange of parts or the making of standard sizes. The writer proposes, in the present paper, to present, briefly, an account of the development in the manufacture of railroad axles on a large scale by pressing, which has been successfully demonstrated and accomplished at the Homestead Steel Works of the Carnegie Steel Co., Pittsburg, Pa.

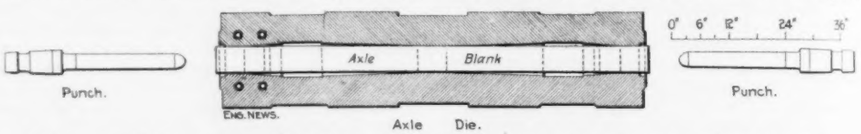


FIG. 1. SECTIONAL ELEVATION SHOWING AXLE DIE, AXLE BLANK AND PUNCHES FOR MAKING HOLLOW PRESSED STEEL CAR AXLES.

GENERAL DESCRIPTION.

In order to produce, by pressing, an axle having varying diameters, the following method was proposed by the writer: A rolled round steel blank, uniformly heated, is inserted into a two-part die, having a matrix cavity in the form of a rough turned axle, Fig. 1. The diameter of the journals is made equal to the smallest diameter of the axle in the center, which corresponds to the diameter of the round blank. After the dies are clamped about the heated round the latter is axially perforated simultaneously at both ends by two cylindrical punches, which force the metal of the blank to conform to the shape of the matrix die and fill out the same. The round is heated up to about 1,000° C. and the total hydraulic pressure required for penetration with a punch of 3 ins. diameter amounts to about 50 tons. During the last end of the stroke a total hydraulic pressure of about 150 tons is required because the blank loses its initial heat through contact with the dies and because the end collars upset, at which time the metal may flow back against the punch.

Considering the small diameter to be pierced and the length of the punch, this pressure required to penetrate the blank is, apparently, very small, and it will be conceded by all familiar with the work that a prerequisite to entering the blank lies in allowing the metal to flow freely in the direction of the forward movement of the punch. The presence of the annular spaces between the blank and the die fulfills this condition, the metal flowing radially in the direction of the least resistance; the only back flow against the punch is at the end of the stroke. It is obvious that if this back flow existed initially the punch would bend and buckle before entering any great distance. In order to facilitate the initial entering of the punch the blank is now gripped by the dies for a length of only 4 ins. at the journal portions, thus allowing the metal to flow more easily. At the first experiments the blank was gripped throughout the length of the journals; and though the punch entered readily, the pressure applied was necessarily higher.

The punch, being tapered, acts as a wedge and the pressure that can be exerted upon the axle blank is consequently enormous. In one of the experiments the heated blank happened to be smaller in diameter than the gripping portions of the dies, and hence was not clamped by them. In this case the punch pushed the metal endwise and upset the blank into the matrix die. The inability of the metal to flow against the punch caused the upper die head, a steel casting weighing 25,000 lbs., to spread, and under a pressure of 200 tons upon the punch the die and the die head broke in the center. It is interesting to note that in this case the punch did not bend in the least, notwithstanding the fact that the blank, instead of being formed round, was compressed into an elliptical section, its upper part next to the top die having ½-in. more metal than the lower portion.

The strength of the cast-steel die head was determined upon the basis of ultimate tensile tests of its material, and it was found that a total lateral pressure of 2,000 tons must have been exerted by the wedge action of the punch in order to break this casting. This occurrence shows that the metal blank, in being punched, can be subjected to an extraordinary pressure. This pressure is exerted throughout the entire length of the axle blank, for it is found that the central part of the axle, where the punch does not penetrate, conforms to the shape of the dies (see Fig. 2). It cannot be disputed that such great compression improves the quality of the steel in the central part of the axle by destroying the injurious effects of segregation and piping usually found in ingot steel.

TEMPERATURE REQUIRED FOR PUNCHING.

Regarding the temperature of the heated blank, it may be mentioned that it is absolutely necessary to have the greatest uniformity throughout the body of the blank, the temperature determining the resistance which the punch must overcome. Table I., given by Dr. Julius Koleman, showing the decrease of ultimate strength for medium hard steel for increased temperatures, may be of interest. The temperatures are given in degrees centigrade and the fiber stress in kilograms per square millimeter:

TABLE I.—Showing Decrease of the Ultimate Tensile Strength by Increasing the Temperature.

Temperature, deg. C.	Tensile strength: Kilos per sq.mm.	Tensile strength: Decrease, %	Temperature, deg. C.	Tensile strength: Kilos per sq.mm.	Tensile strength: Decrease, %
0.....	59	100	650.....	12.5	22
50.....	59	100	700.....	10.5	18
100.....	59	100	750.....	9.1	15
150.....	58.9	100	800.....	7.9	13
200.....	58.9	100	850.....	6.5	11
250.....	57.75	98	900.....	5.4	9
300.....	55.5	94	950.....	4.75	8
350.....	47.5	80	1,000.....	4	7
400.....	32.2	55	1,050.....	3.6	6
450.....	24.1	41	1,100.....	3.2	5
500.....	20	34	1,200.....	2.4	4
550.....	17.5	30	1,400.....	0	0
600.....	15	26			

The values are instructive for the selection of the most favorable temperatures for punching.

The experiments performed at Homestead gave evidence that the lower limit of temperature for successful punching was reached at about 850° C., as near as could be judged. At this temperature the punch entered with difficulty, requiring about 250 tons initial pressure and about 500 tons final pressure for upsetting the collars; the metal, however, filled out the die very nicely, producing a fair looking axle. At a temperature of about 950° C. the pressure required at the end of the stroke amounted to about 250 tons, and at about 1,050° C. a pressure of about 150 tons was found to be sufficient.

RESULTS OF TESTS OF AXLES.

In testing these axles Pennsylvania Railroad drop test specifications were followed, viz., seven blows at 43 ft. of 1,640 lbs. weight, striking midway between supports 3 ft. apart; axles to be turned over after every other blow. The axles, having stood this test, were subjected to further blows until destruction, with results as follows:

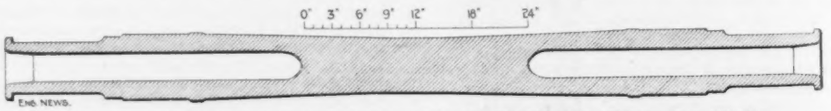


FIG. 2. LONGITUDINAL SECTION OF HOLLOW PRESSED STEEL CAR AXLE.

(A). Axle Blank Punched at 850° C.—Weight of axle, 710 lbs.; diameter of center, 3¾ ins.; size of journals, 5½ ins. The axle broke in the center at the 72d blow. This test was most severe, the axle being turned over after every other blow. The steel had the following analysis: Carbon, 0.39%; phosphorus, 0.024%; manganese, 0.47%; sulphur, 0.026%.

(B). Axle Blank Punched at 950° C.—Weight of axle, 705 lbs. Dimensions of axle same as before. The axle broke in the center at the 56th blow; it was turned after

*Abstract of a paper read at the Meeting of the Iron and Steel Institute of Great Britain.

†Carnegie Steel Works, Pittsburg, Pa.

each blow. The steel had the following analysis: Carbon, 0.42%; phosphorus, 0.02%; manganese, 0.50%; sulphur, 0.02%.

(C) Axle Blank Punched at 1,050° C.—Weight of axle, 700 lbs. Dimension of axle, same as before. Axle was turned over after every other blow, the test being most severe. The axle broke at the center at the 37th blow. The analysis of the steel was: Carbon, 0.54%; manganese, 0.67%; phosphorus, 0.03%.

The steel was too hard, having an excess percentage of carbon and manganese. After rupture, which occurred at the center, the two halves of the axle were weighed and the difference in weight was only 2 lbs., demonstrating the exactness of the shape and the uniform compression throughout the axle.

It is safe, from these tests, to derive the conclusion that by determining the proper temperature for punching the hollow-pressed axles for railway rolling stock can be made of superior quality. These axles are found to have much greater strength than the usual solid axles and the metal is more homogeneous, owing to the internal and external forging exerted upon a thin wall thickness.

METHOD OF MANUFACTURE.

FORGING PRESS.—In order to demonstrate the practicability of manufacturing railroad axles on a large scale by means of punching, an experimental machine, designed by the Carnegie Steel Co., was erected at the Homestead Works, according to accompanying drawings. In Fig. 3 P represents the punching and upsetting press, having two dies, 2 and 3, between which the metal blank is clamped and shaped. The dies have a matrix cavity, giving approximately the shape of the finished axle. The two upsetting punches, 4 and 5, are adapted to enter the matrix cavity longitudinally, being guided by a crosshead, D, and moved in a longitudinal direction by the plungers, 6, of hydraulic cylinders, 7. The punches are made sufficiently long and the plunger is given a sufficient stroke to enable them to penetrate the axle blank lengthwise beyond the wheel seat of the axle. F is a continuous furnace of the Howard Axle Works type, and 8 is a feed table for conveying the blanks. Between the furnace and the press is a straightening machine, 8, composed of a pair of cross rolls, 9 and 10, driven by two 100-HP. electric motors, 11 and 12. These rolls are adapted to receive the blank, cause it to traverse longitudinally and rotate, and by such travel and rotation straighten and round the blank perfectly. The diameter of the cross rolls being unequal, the blank is pressed against a bottom guide placed the entire length between the rolls, thus removing all scale and delivering the blank to the press with a clean and smooth surface. The cross rolls make 160 revolutions per minute and the blank traverses 5 ins. per revolution, requiring about 12 seconds to pass through them. A feed table conveys the blank to a position opposite to a lateral transfer device, 13, composed preferably of inclined skids and of a tilting frame, 14, which may be operated by a hydraulic cylinder, 15. When in this position the axle blank is stopped by coming into contact with a buffer, 16, whereupon the frame, 14, is raised and the straightened blank is caused to roll down upon the bottom die, 3, which is movable laterally upon a slide, so as to carry the blank under the upper die of the press. During its passage to the die the blank is guided at its ends by guides, 17, which center it lengthwise to suit the die cavity. To effect the lateral or traveling movement a lateral track, 18, is provided, upon which are mounted slides, 19, and upon which the die head, 3, when in its lowest position rests and by which it is engaged. These slides are connected by a crosshead, 20, and gearing, 21, to the piston of the hydraulic cylinder, 22, and by the operation of this cylinder the slides carrying the die head and the dies are moved back and forth to the positions shown in the drawing. At 23 are wedges which are mounted under the operative position of the die head and are moved by hydraulic cylinders, 24, forwardly underneath the die head, in order to support and lock it when elevated. The lifting of the die head, 3, is affected by the plunger, 25, which is set directly beneath the operative position of the die head, the axle blank being gripped and held thereby at the center and at the journals. To retain the dies in this positon and to withstand the outward pressure exerted during the forging operation, the wedges, 23, are projected under the die head. The dies, 2 and 3, being thus locked by the wedges, the piercing punches, 4 and 5, are brought into engagement with the ends of the axle blank, whereupon said punches penetrate the blank, pass beyond the wheel seat portions and displace the metal of the axle blank outward, so as to fill the cavities of the dies, forming the wheel seat and taper of the axle of the proper size and contour. The rear portions of the punch engage the ends of the axle blank and force the same inwardly toward the die cavity, and thus, by compressing them, shaping up these ends and forming the collars. The forging of the axle is then completed and it only remains to remove it from the machine and subsequently to turn the journals and wheel seats.

To remove the axle the punches are retracted, the wedges are pulled back, the plunger lowered and the lower die head, with the axle, is carried on the slides to the opposite side of the machine. A hydraulic crane, C, having suspended a beam carrying hooks to enter the open ends of the axle, removes the same from the die and transports it to the cooling bed. The slides are then retracted into the first position to receive the new axle blank and the operations above described are repeated. The construction and the length of the press make it exceedingly difficult, if not impossible, to keep the hydraulic cylinders, the crossheads and the forming dies in a permanently correct alinement; therefore the ends of the piston rods were made to engage a ball bearing mounted in the crossheads, rendering the cylinders independent of the other parts of the press, so that only the forming dies need to be alined correctly with the crossheads holding the punches. To bring the crossheads holding the punches into a perfectly straight line with the dies the crossheads rest upon false plates, which can be raised or lowered by wedges, 26, allowing adjustment of the height, and the guides are made adjustable by set bolts, 27, giving adjustments in all directions. Similar means are provided for the adjustment of the upper matrix die to make it conform with the punches in case the dies are exchanged. The fastening of the punches to the crossheads was found to be satisfactory, the resistance to compression being taken up by a long taper, and that to pulling, which is comparatively small, by a locking wedge so that the punches can be changed very rapidly. For upsetting the end collars of the axle the rear end of the punch is provided with a movable ring, 28, and by changing the thickness of this ring the length of the punch may be adjusted to properly fill the dies.

PUNCHES.—Many experiments have been made regarding the material for the punches. Water-cooled tool steel punches with cast-iron points removably secured were first tried. Such a punch afforded the necessary stiffness, and the cast-iron nose withstood heat to a great degree, being self-lubricating and not liable to become welded within the blank. The securing of the cast-iron nose to the punch was found, however, to be too weak, owing partly to the smaller diameter of the punch and partly to the fact that having at that time no cross rolls, the blank was not straight, and the punch followed the course of the blank and hence fractured, the nose breaking and remaining in the axle. Solid crucible steel punches were then tried, but it was found that by the great pressure exerted the point of the punch welded to the axle blank, requiring great power to extract it. The point of the punch was covered with steel from the blank and was ragged, and therefore unfit for a second opera-

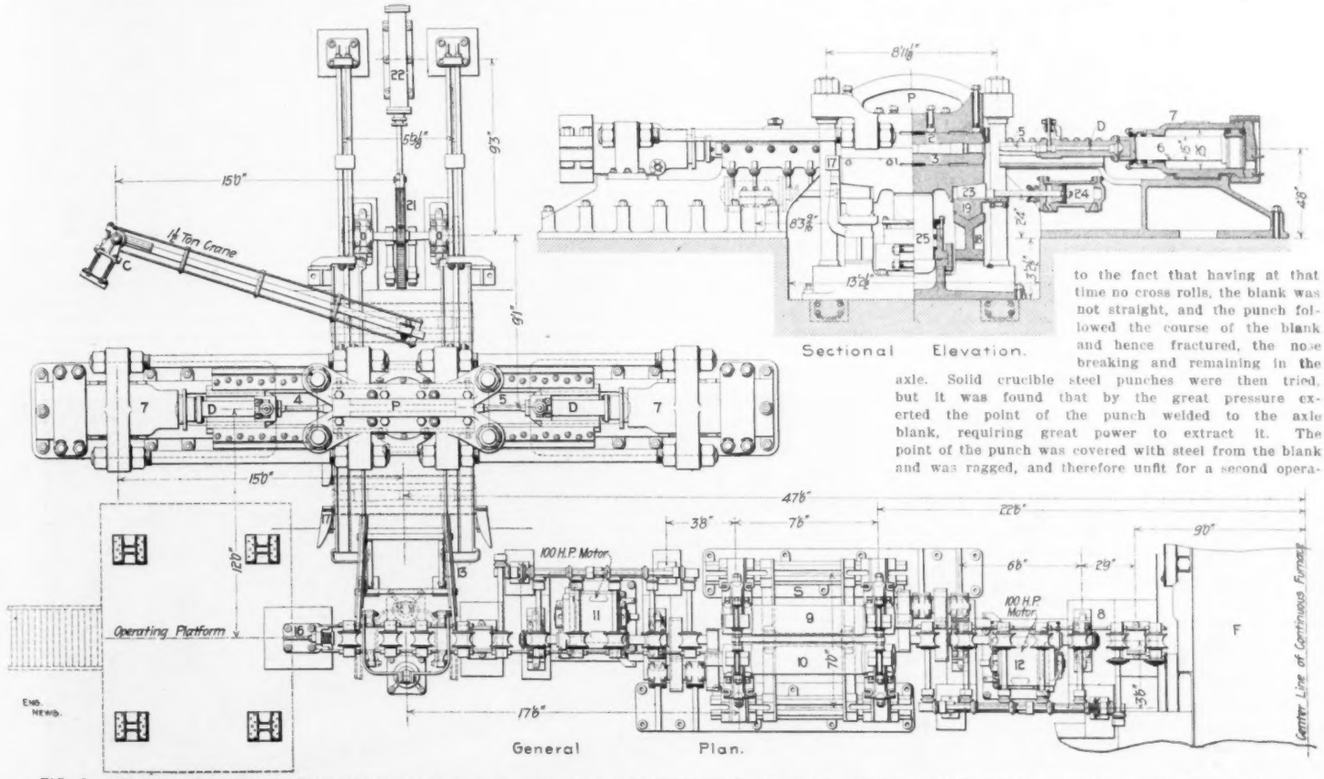


FIG. 3. DETAILS OF APPARATUS FOR MANUFACTURING HOLLOW PRESSED STEEL CAR AXLES, HOMESTEAD WORKS, CARNEGIE STEEL CO.

tion. To avoid the welding the punch was entered first for only 6 ins., then removed, the cavity filled with hard coal and the punching operation finished. The punch, being sufficiently lubricated by the gases from the coal, did not weld, but was caused to deviate on account of the coal not being evenly distributed around the punch. Solid charcoal iron punches were thereupon tested, but under the great pressure required for penetration they bent before entering the blank, deviating accordingly. If the temperature of the blank was high enough the deviation amounted to only about 1-16-in., but if the steel was too cold the punches broke in the outer part, the broken end remaining in the axle.

In figuring the strength of these punches 35 tons are required to make them deviate 1-16-in., showing again the small pressure required for punching. On the other hand, this deviation necessarily followed from the fact that the length of the punch was eight times its diameter, whereas it should not be over five times, according to accepted authority for cast iron. It may be 12 times the diameter for steel, or even more, according to percentage of carbon and treatment. As a result of these experiments, and following the practice of the Ehrhardt Works in Montbard, France, high carbon Bessemer steel containing 0.9 to 1% carbon was adopted and the punch was found to be very stiff. To overcome the difficulty of the welding, the ends

of the punches were provided with drop-forged steel caps—Fig. 4. These caps rest on the point of the punch, fitting the same neatly, and are a little larger in external diameter than the punch, in order to avoid friction between punch and the blank, resulting in a minimum of pressure required for penetration. By the pressure the caps are welded to the blank. The punch, being protected from injury, is very easily withdrawn, and, after cooling, it is ready to receive a new cap for the next operation. This arrangement proved to be very satisfactory and practical. The caps can be made very cheaply by drop forging them from steel plates or skelp or preferably from axle steel. In order to avoid heating up of the punches they are preferably black-leaded, this being carried deep into the blank, the pierced hole having a greater diameter than the punch, owing to the slightly larger size of the cap.

The results due to the intermediate straightening of the axle blanks are of the greatest practical importance for the preservation of the punches, as it saves them from bending. It is evident that if the blank reaches the dies in a bent condition, owing to the presence of the cavities, the blank will be straightened only in those parts gripped by the dies, leaving the blank unsupported between the journals and the center. The piercing punch, entering the center of the blank and having equal resistance in all directions around the punch, will follow the center of the blank; consequently, if there is a bend the punch must deviate.

DIES.—The material employed for the matrix dies is best machine cast iron, water cooled to prevent a change in the shape and dimensions of the cavities. The dies show very little sign of wear and tear, and it appears that they will withstand the punching of a great number of axles, since the slight wear only smooths the inner surfaces of the dies. Further experiments in this direction might lead to the adoption of cast-steel dies. To remove the axle readily all corners of the die are tapered, and to prevent sticking the cavities are preferably black-leaded.

GENERAL.—As already mentioned, greatly improved results are obtained and much wear and tear of dies prevented, if after heating the blank and before it is upset in the dies it is subjected to a straightening operation and rendered as perfectly straight as possible, instead of relying upon the dies themselves to remove the bends and irregularities which are necessarily produced during the heating of the blank in the furnace. Furthermore, by this step the scale gathered in the heating furnace is removed, and the rolled blank is made exactly true in diameter and perfectly round, delivering the axle blank in an ideal condition to the dies. To conform to the contraction of the steel in cooling off the cavities of the die correspond to the size of the axle in the hot state. The displacement of the punches is about 1 cu. in. greater than the difference between the cubic contents of the cavities and the blank, owing to the compression of the metal.

In order to cover all possible conditions and emergencies in the manufacture of these car axles the press should be designed for about 350 to 400 tons, total pressure being about 1,500 lbs. hydraulic pressure per sq. in. To lengthen the life of the punches and avoid liability to their injury by heat, the piercing should be carried out very rapidly. This can be accomplished in four to five seconds by connecting the hydraulic cylinders and the accumulator with a correspondingly large pipe line and by using specially designed four-way operating valves. The auxiliary parts of the press require for their operation a hydraulic pressure of 500 lbs. per sq. in. The quantity of water needed is comparatively small. One 22 × 36⅜ × 5¾ × 36-in. high-pressure pump and one 22 × 36⅜ × 10 × 36-in. low-pressure pump, requiring a total of about 200 lbs., are sufficient to serve four presses, capable of punching of 1,200 axles in 20 hours.

One continuous furnace and one pair of cross rolls furnish the blanks to two presses, alternately delivering one blank every two minutes. The length of the continuous furnace for heating the axle blanks is sufficient to retain 90 blanks at the same time, each blank remaining in the furnace for three hours, giving, therefore, ample time for the steel to become uniformly heated and soaked throughout. The bottom of the furnace is inclined toward the hearth, and the blanks, instead of being pushed by hydraulic power, are rolled into it, dispensing with a hydraulic charging apparatus and the customary cooling water pipes needed to protect the bottom from wear and tear. The blanks are gradually roled down the incline toward the hearth, and when ready for punching are rolled into a discharge groove containing two water-cooled pipes placed close together to receive the blank and guide it out from the furnace when pushed by a hydraulic pusher toward the cross rolls.

With the experimental plant erected in Homestead the time required to make one axle, all operations included, did not exceed two minutes. Allowing, again, two minutes for cleaning and black-leading the dies and for cooling and capping the punches, the capacity of one press will be 15 axles per hour, or 300 axles, 5½ × 10-in. journal, per 20 hours, which is fully three times the quantity accomplished with one hammer by the best American practice. The number of men required to operate the press remains the same as needed at the hammer to forge five 5½ × 10-in. journal axles per hour. The machine above described has many advantages. It is effective in construction and produces a strong and light axle which contains the cardinal combination desired—namely, minimum weight and maximum strength.

ADVANTAGES OF HOLLOW PRESSED AXLES.

Axles made as above set forth have more resiliency than the present type, and are not, therefore, liable to fracture from sudden strains. Their use in railroad car construction results directly in material economy, not only over solid axles, but over any other species of hollow axles known to the writer.

Broadly speaking, hollow axles are old, but such axles have been made either by casting them the shape desired or pressing them hollow throughout and then forging on a mandrel or by boring out solid metal. These methods are each objectionable, because they either fail to produce axles of sufficient strength and lightness or are too expensive for general adoption. The end portions of this axle are, of course, hollow, the cavities extending beyond the wheel seat, but this is an advantage because the forging action which is produced by the entrance of the punches greatly compacts and strengthens the metal and renders the axle less liable to break. The combination of hollow ends with solid center has the advantage over hollow axles that all requirements for the drop tests and for torsion, produced in curves, are fully covered. It is obvious that a hollow axle will soon deform in the center under the drop test, rendering the test uncertain.

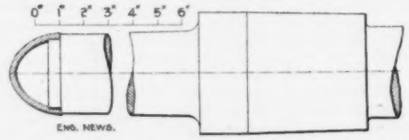


Fig. 4. Details of Punch with Removable Point for Making Hollow Pressed Steel Axles.

Regarding the change from a hollow to a solid section, it is important to have the section increased uniformly, avoiding any sudden changes, and accordingly the point of the punch is made to conform to the curve of a parabola. Any vibrations produced in the axle by going over switches and crossings are to be transmitted and absorbed throughout the body of the axle uniformly and in the most natural way, without fatiguing the metal in any section of the axle. This uniform transmission and absorption of the vibrations is also facilitated by the fact that the density of the metal changes with the section, being least dense in the solid part, the vibration thus flowing from the lighter to the more compact sections, as water would flow, following an easy curve without stowing. In actual practice the solid axle usually breaks or becomes fractured at the juncture point of the journal with the wheel seat or in the body back of the wheel seat, owing generally to segregation and piping, or to detailed fracture. By the new process of manufacture this is believed, and has been proven from experiments, to be entirely prevented. The metal is effectively worked from the center of the axle and from the ends of the journals.

The greater stiffness and strength of the hollow pressed axles were demonstrated, not only by the drop tests, but furthermore confirmed by the following loading test: A Carnegie ore car having one truck fitted up with solid standard axles, the other truck with hollow pressed axles, was loaded with 96,500 lbs. of limestone, the gross weight of the car being 131,600 lbs. The difference of the deflections measured with the instrument in the center of the axles for the loaded and empty car was 1/128-in. for the hollow pressed and 1/32-in. for the solid standard axles, showing a greater deflection of 3/128-in. for the solid axles. To minimize this bending is, of course, of the greatest importance for the durability of the axle; when the car is in motion its effects produce a continuous change of strain in the different parts of the axle, the lower half being in compression, the upper half in tension, causing eventually detail fracture, and consequently the smaller the deflection the greater the durability of the axle, the reduction of the deflection being proportional to the square of the life of the axle.

It will be understood that heretofore, in the finishing of an axle, it has been greatly weakened by cutting away the outer skin, which has been compacted by the forging operation; but in the use of the present system a tough dense skin is produced on the interior of the axle by the forging action of the punches, and this skin is not cut away, but remains a permanent element of strength, and the tough external skin is cut away only at the end portions. It is unnecessary, as heretofore, to machine the axle throughout its entire length, for by the dies it is compressed to exact length and made so true that it is sufficient if only the journals and wheel seat portions are turned or machined.

Tests made last year by the Howard Axle Works and the Altoona shops of the Pennsylvania R. R. upon 24 5½ × 10-in. journal axles to determine the relative strength of smooth forged and rough turned axles, employing tensile and drop tests for this purpose, gave the following average results of the drop test:

Heat number			13,008	21,719	12,768	Aver'ge
Smooth forged			61	39	34	46
Rough turned			43	32	32	39
	Smooth forged.			Rough turned.		
Heat No.	Carbon.	Tensile strength lbs. per sq. in.	Elongation, %	Carbon.	Tensile strength, lbs. per sq. in.	Elongation, %
13,008	38.0	63,632	22.4	38.9	63,648	22.3
21,719	44.5	71,307	21.0	44.8	70,446	21.0
12,768	48.9	78,232	17.3	50.2	77,811	17.8

It was noticeable that all the smooth-forged axles developed quite extensive longitudinal seams before failure, and that these appeared to have no influence whatever on the results, some of these having the most pronounced seams standing the best tests; also, just before failure, the turned axle developed cracks which followed the tool marks, indicating clearly that these had weakened them.

Neither the variations in finishing temperature nor the amount of material removed from the turned axles appeared to have any influence on the results.

From this it appears that the smooth-forged axles are stronger than the rough turned, and that the difference is the more marked the lower the carbon.

In order to machine these axles upon the ordinary lathes false centers are inserted into the hollow ends.

EFFECT OF TEMPERING.—If desired, the entire axle may be subjected to a tempering operation, this being preferably an oil-tempering process, whereby the entire mass of metal will be tempered and refined, thereby increasing the ultimate strength and power of the axle, and at the same time improving the quality of the friction surfaces of the same. This form of axle permits the oil tempering to reach the inner vital parts thereof with the best results, so that those portions of the axle which, in use, are subjected to the greatest strain are rendered of superior effectiveness and increased power.

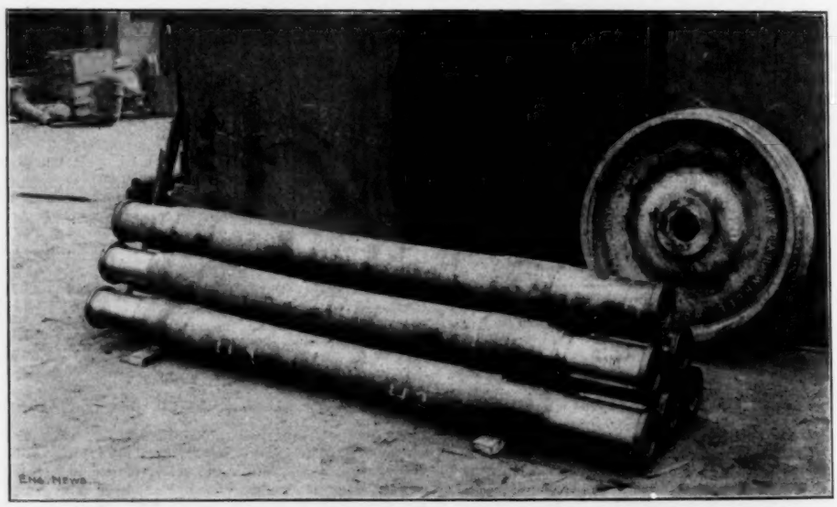


FIG. 5. VIEW OF GROUP OF HOLLOW PRESSED STEEL AXLES, SHOWING ROUGH AND FINISHED CONDITIONS.

The drop test results of an oil tempered and annealed hollow pressed axle are given herewith:

(1) Axle Blank Punched at 950° C.—Axle oil tempered at 770° and annealed at 640° C. Weight and dimensions as for axles previously described. The axle broke at the center at the 67th blow. The steel contained: carbon, 0.43%; manganese, 0.47%; phosphorus, 0.02%; sulphur, 0.048%.

The axle was in the heating furnace for one hour and 55 minutes, and left it with a temperature of 770° C. It was then delivered to an oil bath, where it remained one hour and four minutes. (This excessive time in the oil bath was occasioned by the crane being engaged with other work.) After removal from the oil bath the axle was recharged in the heating furnace, leaving same after 1 hour and 55 minutes with a temperature of 640° C., and remaining in the annealing pit for five hours. In connection with this test it may be of interest to state, especially in northern countries, that the axle lay on the ground in the open air for about five hours before drop testing, the atmospheric temperature being about 10° C. below zero, and considering the small deflection after the first blow (3⅝ ins.) this test can be regarded as remarkable, putting at rest any suspicion that the axles are unsound in any particular part; for example, at the junction of the solid and hollow part. The breaking of the axles always in the center demonstrates beyond doubt that the use of the hollow ends with a solid body combines all the qualities and advantages of both a solid axle and a hollow axle, the resisting power being almost equal to a solid nickel-steel axle.

Regarding the quality of the steel, ordinary axle steel specifications are sufficient. The requirements are that the blank be free from seams, the diameter of the rounds be within 1-32-in. of that specified, and in the length of the blank a variation of ¼ to ⅝-in. is permissible. Providing the mill round is not true, which variation in ordinary practice usually varies 1-16 to ⅛-in., the blank in passing through the cross rolls is reduced to a perfect circle and the excess material, elongating the blank over the normal length, must be taken care of in the press. For this purpose one end of the dies forming the end collar on the axle is turned out sufficiently large to provide a receptacle for the flow of this excess length, thus permitting the punches to enter the axle to a uniform depth, thereby insuring at all times a uniform axle, conforming exactly to the form of the dies. The excess diameter of the collar is readily reduced to requirements in the lathe. Of course seamy steel will produce cracks upon the surface of the axle, due to the expanding action of the punch. This fact is very important, as it prevents the making of a defective axle without being detected, makes rough turning over all to show up defects unnecessary, and even the drop tests may, in time, be discarded and only surface inspection be required, because a hollow-pressed axle without any cracks furnishes the best proof of the railroad companies of receiving an axle of the very best quality.

The advantages of a hollow-pressed axle may be summarized as follows:

1. The axle has a perfect form; its shape can be best adapted to resist the strain to which it is subjected with the least amount of metal, combining minimum weight with maximum strength.

2. The forging effect being carried out throughout the material, both internally and externally, the material is found to be far more homogeneous than solid axles made in the usual manner, segregation is destroyed and; consequently, the axle is much more reliable.

3. The journals, being highly compressed, will in finishing attain a more highly polished surface, thereby minimizing the friction, resulting in economy of draft.

4. The journals, being hollow, will remain cooler and permit the storage of a considerable quantity of oil, removing herewith the chief cause of hot journals, also economizing materially in the expenditure for lubrication.

5. No straightening after punching is required, the axle being as straight as the die, thereby eliminating entirely the injurious effects of the gagging operation.

6. No centering, no cutting of the ends, no rough turning is required, thereby saving considerably in finishing labor and increasing the finishing capacity of existing plants.

7. The punching of treble the amount of axles as compared with forging with an equal number of hands, resulting in saving of forging labor.

8. Considerable saving in steam consumption and fuel.

9. The detection of a defective axle without performing any extra work—that is, without the necessity of rough turning it over all, which provision is now included in the latest M. C. B. specifications.

10. Approximately uniform fiber stresses throughout the body of the axle, due to the straight and uniform taper between the wheel seats.

11. A saving of 33% of steel in the manufacture.

12. Present drop-test specifications need not be changed.

13. The possibility of supplying uniform axles, limiting the weights and dimensions to a minimum.

14. The weight of a 100,000 lbs. capacity steel car is decreased by 1.7%, permitting this load, which amounts to 24,000 lbs. in a train of 40 steel cars, to be carried without any additional expenditure of energy. Converting this advantage into other channels, there would be a corresponding saving in coal consumption or tractive power.

The system is, of course, easily adaptable for the smaller sizes of axles, with a corresponding decrease in the cost of installation.

In punching these axles, by the pressure applied the protecting caps are welded to the axle blank and therefore it may be safely concluded that any cracks which may be caused by the primary work in the solid part of the axle will be eliminated by the action of the punches.

REMARKS ON ETCHED DISKS AND MICROSCOPIC SPECIMENS.

There are two important factors which enter into the strength and durability of the finished axle. The first is the amount and the penetration of the work which is put into the steel from the time it is rolled in the blooming mill until it receives its final shape under the hammer, or, as is now proposed, in an hydraulic press, preparatory to being turned up in a lathe for service, and second, the temperature to which the steel was heated.

The etched disks shown in Figs. 6, 7 and 8 were prepared to illustrate these points. The disks were cut from the portions of the axles as indicated and after polishing, were etched with 5% sulphuric acid for 10 hrs.

The disk from the journal of the solid axle shows in the center practically the same grain which existed in the bloom as it came from the rolling mill, and on the edges a very much finer appearance where the work from the hammer has penetrated. This fine grain is not equidistant from the outside at every point, but has an oblong shape, the greatest depth corresponding to the edges of the bloom (7½ × 8½ ins.).

The disk taken from the center of the hollow-pressed axle shows a much more uniform grain, corresponding to the finer portion of the solid forged axle. In the neighborhood of the center the grain is slightly coarser. In the case of the disks cut from the journals from the ordinary (cooled in air) and the oil-tempered hollow-pressed axle, the grain is practically the same, with a very fine grain extending inwards a short distance from each surface. These illustrate the first point as regards work, and show that the hollow-pressed axle is very much superior to the ordinary solid-forged axle.

The misroscopic specimens show that the regions of the axles near the surfaces have a much finer structure than in the center, except in the oil-tempered axle, which is very uniform throughout. In the case of the solid-forged axle, the outside was penetrated by the work to only a comparatively slight depth, and being cooler than the interior (due to the air and the cold hammer and die) has a fairly fine structure while the center shows that due to the highest temperature to which the bloom was heated. The hollow-pressed axle received work all through it, but as the portions coming in contact with the die and punches were cooled to a certain extent, they were worked at a lower temperature than the center, which was very nearly as hot as when it came out of the furnace. Since the oil-tempered axle was reheated to above the critical point (to 760° C.) it shows a structure corresponding to that temperature. The oil-tempered axle stood a better test under the drop than the one simply cooled in the air, thus showing that the finishing temperature had something to do with the result, but the most important factor is the size of the grain as shown by the fracture, or on etching a polished disk, evidenced by the fact that so far the pressed axles have stood more uniformly good tests than the solid axles, although occasionally the latter have withstood as many as 60 odd blows of the drop.

From a commercial standpoint it would, of course, be impossible, under existing conditions, to oil temper axles successfully.

No troostite* was observed in the oil-tempered specimens, but this would be accounted for by the fact that the mass being so large, the cooling was not sufficiently rapid.

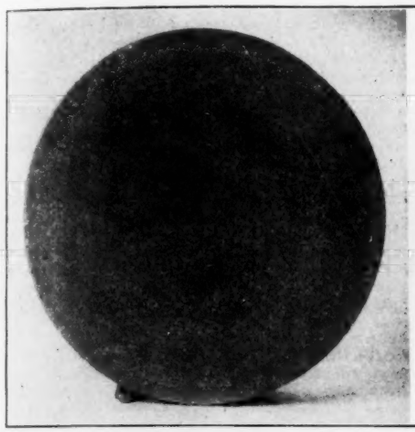


Fig. 7. Etched Section at Middle of Hollow Pressed Steel Axle.

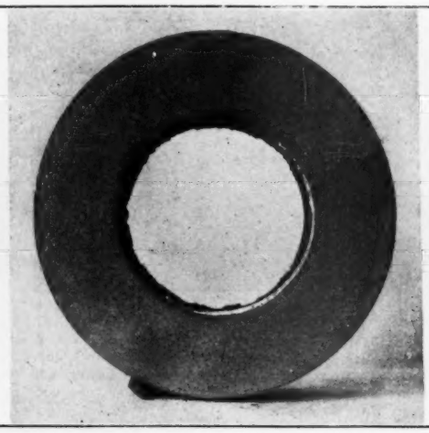


Fig. 6. Etched Section of Journal of Hollow Pressed Steel Axle.

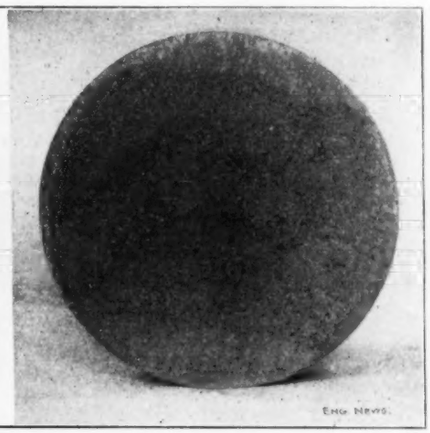


Fig. 8. Etched Section of Journal of Solid Forged Steel Axle.

PUDDLED IRON AND MECHANICAL MEANS FOR ITS PRODUCTION.*

By James M. Roe,† M. Am. Inst. M. E.

Steel has occupied such a prominent position in most minds during the last 30 years, particularly since the introduction of the basic open-hearth process (by which the field from which the raw material could be obtained has been so widened), that little attention has been made to improvements in puddling iron. In fact, the general tendency seems to have been to accept the prediction that puddled iron is doomed. Events have in a measure justified such a forecast, due in large part to the introduction of mechanical appliances and operating with large units in the manufacture of steel, from which so much lower costs have resulted. But this general tendency has met checks in certain directions. This is notably the case where the finished product is a welded one, or is subject to oxidation, to shock or to vibration; and, as far as the writer's observation goes, the bond (which is largely a mechanical one) is not as close and lasting between steel and tin or zinc as between iron and the same materials. The field still open for puddled iron is, therefore, a large one, provided the low costs of steel manufacture can be approached.

The process of puddling is one of the most interesting in the metallurgy of iron, as the reactions and the changes effected are apparent. The subject has had the strongest fascination to the writer from boyhood, and has led, not unnaturally, to a close study, which long ago resulted in the conviction that it could be successfully carried out with large units and by mechanical means. That others have also drawn these conclusions is shown by many un-

*F. Osmond, Method Generale, "Contribution a l'étude des Alliages," p. 294.

*A paper read before the American Institute of Mining Engineers.

†Mechanical Engineer, Superintendent Iron Works, Glasgow Iron Co., Pottstown, Pa.

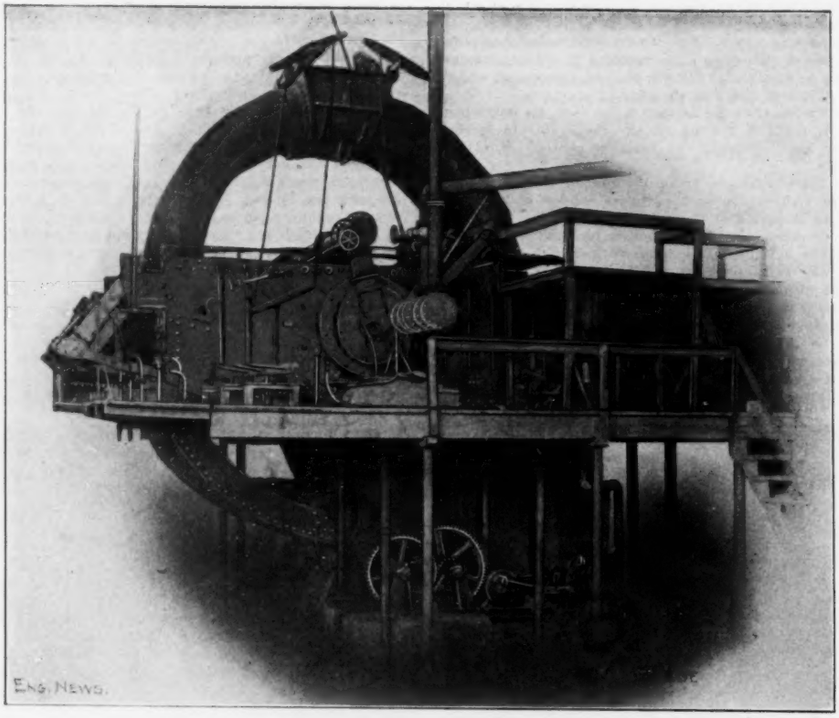


FIG. 1. GENERAL VIEW OF ROE'S PUDDLING MACHINE.

dertakings, though there have been few such attempts during the last 25 or 30 years.

Puddling consists, essentially, in the removal of most of the carbon and silicon, and part of the phosphorus and sulphur from pig-iron by agitation, while molten, in the presence of suitable cinder and gases of the right composition and temperature. These are, broadly, the conditions up to the period of balling, which final operation will, of necessity, differ when carried out by manual or mechanical means.

The process developed by the writer is being carried out in the machine or furnace illustrated by Figs. 1, 3, and 4.

The general framing consists of two side-plates, suspended from a trunnion on each side, carrying the whole machine, and these trunnions rest upon roller bearings supported by an elevated framework. The side-plates are extended underneath, forming segments of circles, to which the operating racks are secured. These gear into pinions driven by a reversing engine. Between the side plates are four distance pieces, which form girders from one trunnion to the other. The stack bases and the angles under the bottom also serve both to form part of the framework and to strengthen it.

The bottom, consisting of a series of water-cooled parts, rests upon the angles referred to and supports the working bottom of magnesite brick. This material is also used to line the end and sides, up to the wash line of the cinder; the sides above the cinder line, the roof, and the lining of the four stacks being built of firebrick.

At present, the furnace is fired by means of crude oil and blast; but coal or gas can be used, should convenience or economical reasons require it. Oil was adopted in the present instance on account of convenience of application and ease of regulation. The fuel is introduced through the two trunnions, which form efficient combustion chambers, and the flames directly impinge on each other at the middle line of the furnace, thus producing a most intense and thorough combustion. The flames then pass to the four converging stacks, two of which are at each end of the furnace, and by this means a complete filling of the shamber is assured.

The whole of one end of the furnace is closed by a door built up of removable sections, and suspended from a shaft running across the furnace. The door is opened and closed by two side connecting rods, which connect the bottom girder of the door to a cross-head operated by a hydraulic cylinder under the furnace. Parallel motion in the cross-head is assured, by means of pinions at each end, engaging in racks fastened to the side-plates of the machine. The closed door is locked by means of wedges, operated by hydraulic cylinders, which pass through the side plates and the connecting rods. The wedges also aid in making tight the joints of the door.

The top, bottom and side edges of the door are made with a ⅛-in. radius in order to crush and grind out any cinder left on the sill, lintel or jambs at the time of discharging the ball. The sill and lintel are formed with water-cooled convex surfaces (extra heavy pipe), to chill the cinder in making the joint before charging, and to make it crush and part more easily when the door is closed after discharging.

The bottom is rectangular in plan, being about 20 × 8 ft. 8 ins. in the clear, while the sides and ends are straight and stand at right angles to the bottom. The form of the furnace is, therefore, the simplest possible, and the one which is the most easy to maintain. The high roof in the middle gives room for flame development. It slopes down, to direct the flame against the bottom, and rises again to allow sufficient space for the wash of the bath at the ends.

The machine can swing through about 65° on each side of the center line of the trunnions. It is, therefore, a puddling furnace in which the necessary agitation for producing an intimate mixture of the molten metal and oxides is obtained by allowing them to run down hill, first in one direction and then in the other, and suddenly arresting them at the bottom. The subsequent balling of the iron, when it has come to nature, is produced by precisely the same means.

It has been sought to embody in the present effort, as far as possible, the general practice in steel works, since there is but one period in the production of iron (that from the beginning of crystallization to the squeezing of the mass) where the change from pig iron to wrought is necessarily different from that of steel.

The bottom, sides and ends of the furnace, being formed as described, are intended to possess relatively permanent characteristics, thus differing radically from the cinder bottom and sides, fixed with ore, from which much of the cinder necessary for puddling is obtained in the ordinary furnace. It is necessary, therefore, to charge molten cinder into the puddling machine as an equivalent, which is melted in an auxiliary furnace designed for the purpose. The tap-cinder from the ordinary furnace is used for this purpose, and is not an active puddling agent. It serves principally to seal the door joints; cover and protect the bottom in a measure; to present a medium for retaining the phosphoric acid; to form a lubricant as the iron comes to nature and is massed; and, finally, to act as a welding cinder in the ball. Roll scale is added during the process, to act as the principal puddling agent.

It is intended to use molten iron from a blast furnace by charging it into a mixer, and drawing the iron from that as needed by the puddler. At present a cupola is used. This latter, however, is open to two objections: greater cost and increased difficulty in obtaining low sulphur.

The molten iron (in the existing machines varying from 3,000 to 4,000 lbs.) is poured through the charging-hole immediately after the cinder, and as soon as the iron is charged the machine is oscillated two or three times. Then the oxidizing agent (roll scale or easily reduced iron ore) is added by means of a long spoon (made of a piece of pipe, cut in two longitudinally), which is run in through one of the end peep-holes, given half a revolution and withdrawn, thus evenly distributing the scale through the bath. This is continued between oscillations until sufficient scale has been added. This stage is indicated by free iron ceasing to run on the bottom, or the bath rising for the high boil. This latter is much more active than in an ordinary puddle furnace. Large volumes of carbonic oxide are emitted, which burns above the surface of the bath to carbonic acid, materially raising the temperature of the furnace and the bath without additional fuel. During the periods of scaling and boiling, as the bath descends the incline hearth it is thoroughly agitated and uniformly mixed; in part by the lower strata being retarded by friction on the bottom, allowing the upper strata to flow over the lower, and, more largely, because, as the direction of the bath is suddenly arrested at the end, it turns over upon itself presisely as an ocean wave does.

As the iron comes to nature and thickens, the progress down the hearth from end to end becomes slower, so that the clusters pass slowly through the zone of highest temperature and acquire the heat necessary for thoroughly welding the whole together in the ball. This massing, or balling, is accomplished by increasing the angle of the

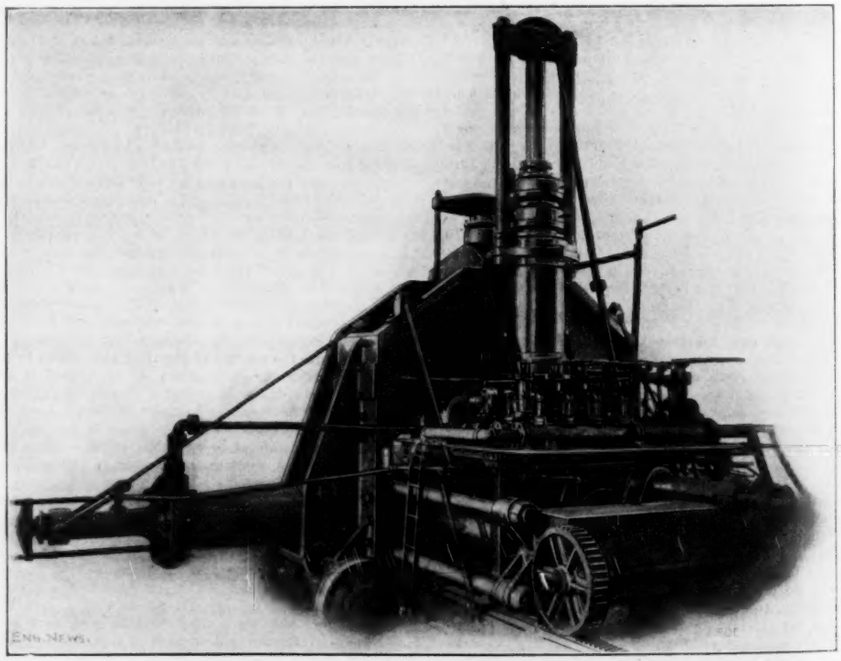


FIG. 2. THE HYDRAULIC SQUEEZER.

hearth so that the mass slides with sufficient momentum to compress and solidify itself. This mass, or ball, has a length about equal to the width of the machine, a width of about 3 ft., and a height of 24 to 30 ins. When the balling is completed, the side-rod wedges are withdrawn. As the front end of the machine descends, the door is opened, and the mass is discharged by gravity directly into the squeezer. Any free cinder that may exist is discharged ahead of the mass, and falls in front of the squeezer. The door is then closed, and locker, the cinder is poured in, and the machine is ready for the next heat.

Before following the puddled mass further, it is desirable to call attention to the squeezer.

The coffee-mill squeezer is almost universally used today, in conjunction with the ordinary process of puddling iron and working with the balls weighing about 180 lbs. Although it is in this case probably as effective a mechanical device for a given end as was ever designed, it is not equally well-fitted for handling masses now weighing 4,000 lbs., and which, in the future, probably will weigh 10,000 lbs., since the product sought is to be of square or rectangular section.

Hence a special squeezer had to be designed to meet the conditions, and took the form shown in Fig. 2. Hydraulic power was selected. The pressure is applied in one horizontal direction, by means of a front girder operated by the cylinder in the rear; and, at right angles to this, it is applied by means of the two end cylinders. At present the bloom has a fixed length of 54 ins. and a width of 24 ins. The vertical pressure is applied by means of the top cylinder. In order to increase the final pressure, an intensifier is mounted on the squeezer, which raises the pressure from the initial 600 lbs. to 2,500 lbs. per sq. in., thus giving a pressure of 1,800 tons on the top area of the bloom. All of the facing plates which come in contact with the mass are sectional, and have spaces between them for the egress of the cinder as it is squeezed out of the bloom.

The return motions of the various parts are effected by smaller hydraulic cylinders, and, by similar means, the bloom is pushed from under the head piece to the open front.

The whole is mounted upon four wheels, which run on rails extending in front of and parallel to a series of puddling machines. One squeezer, therefore, would take the balls from all the furnaces and deposit them at a point convenient to the blooming mill.

The specific object in having a movable squeezer is to avoid any delay at this important period, as it is vital that the iron shall be put together before the projecting clusters cool. Besides this, rapid oxidation takes place when the ball is exposed to the atmosphere, thus causing a loss, and producing an infusible oxide, which tends to prevent welding and a thorough removal of the cinder.

The squeezer has proved very effective in shaping and solidifying its product. There has been some trouble in freeing all of the blooms from cinder; but, judging from the number which have been so freed, and from the fact that the trouble is not in an aggravated form in any, it is believed that, by giving the cinder more freedom for egress, the result will be equally satisfactory in this direction as in the others. All the operations on the bloom, after it has left the squeezer, are identical with those now applied to steel, thereby extending the economy of production to the finishing mills.

Comparison seems so essential to many conclusions that it is almost necessary to point to some features in the Cort process, as improved by Rogers, in order to obtain a just conception of the present effort.

The conditions throughout the bath, or heat, in manual puddling, lack uniformity. This is recognized by all practical puddlers when they select a bar for testing. This lack of uniformity is cured, in a large measure, at the finishing mills by piling the good, bad and indifferent together, thus producing a mean that meets requirements. Hence, apart from the inability of manual means to furnish a mass of sufficient size to finish direct, the product so made would vary so much that the proportion of inferior material would condemn the whole. On the other hand, the product of the machine under discussion is relatively uniform throughout a given heat, and is, therefore, well-fitted to roll directly into a finished product. This can be done, provided there is work enough, that is, a sufficient number of reductions in section from the squeezer-bloom to such product. The samples of iron plates and an etched section of squeezed puddle-ball, made by this process, go far to combat the usual statement that repeated working and heating of iron is necessary to produce a good product. This statement is illogical. It is impossible to conceive that there can be any inherent virtues in a second or third heating and piling, other than accomplishing something that had not been done in the prior heating.

The requirements in the material for good results in rolling or forging iron or steel are, homogeneity, mass enough to give opportunity for the necessary work (reduction of section) and to retain the temperature, and pressure enough (heavy and effective machinery) to accomplish the desired end before the heat is dissipated. This has been confirmed in modern steel production.

The puddler and squeezer, although, presenting some of the shortcomings inevitably associated with being the first of their kind, have, in the main, fulfilled their mission of development satisfactorily, which is shown by the following summary of results in conjunction with the samples obtained.

The pig iron used has varied in composition as follows:

Sulphur	0.03 to 0.26%
Phosphorus	0.50 " 1.35%
Silicon	0.60 " 1.40%

Many of the heats have shown a satisfactory elimination of phosphorus, and, as was to be expected, this elimination has been shown to depend upon the composition and condition of the cinder and the manipulation of the bath during the period before the iron comes to nature.

Some elimination of sulphur has been shown, but, as a general rule, this element should be kept as low as possible in the iron charge. Those heats which have been made with iron taken directly from the blast furnace have shown the special advantage of such a practice in this respect. The cinder used has a normal composition of about sulphur 0.30, phosphorus 1.73 and silica 20%. Ordinary roll scale was used for the additions.

The weight of pig iron charged has generally been between 3,000 and 4,000 lbs., although some heats as low as 2,500 lbs. have been made. The average is 3,500 lbs.

The weight of cinder has varied considerably. It has been shown that about 500 lbs. per ton of iron (22 to 25%) is the proper amount. The amount of scale used has run from 350 to 550 lbs. and depends entirely upon the individual characteristics of the heat, such as the character of the pig iron, the temperature of the bath, etc., just as it does in the ordinary process.

The time required to make a heat has, of course, varied very much, especially at first, running from 24 to 102 mins. The average duration is 48 mins., but it is believed that 40 mins. for a 4,000-lb. charge will be the average under regular running conditions. This would mean from 15 to 18 heats per turn of 12 hours, or a product of from about 27 to 32 tons of rolled slabs or blooms.

While some heats have shown a loss, and others a gain, between pig and slab, the indications are that the weight of the rolled slab will be about equal to that of the pig-iron charged, or will only slightly exceed it. The loss from slab to finished plate, however, runs from 5 to 6%, thus coming close to that of steel, while in the ordinary puddling process it is about 16%. This difference is largely due to the fact that the iron is heated to a higher temperature with a consequent higher heating loss. The difference in finishing loss is, however, more than compensated for by the fact that all of the iron made is in the slab, there being no crop ends such as are necessary when steel slabs are rolled from ingots.

The physical tests made on this material show better results than those from plates of similar analysis made from ordinary puddled iron. For instance, the samples obtained from plates containing sulphur 0.016, phosphorus 0.10, and carbon 0.05%, give an ultimate strength of 51,000 lbs. per sq. in., with an elongation of 24% in 8 ins.; while that from a plate containing sulphur 0.019, phosphorus 0.13 and carbon 0.10%, gives an ultimate strength of 62,000 lbs. per sq. in:. with an elongation of 23% in 8 ins. The latter is a material which may again open to iron the large field of shipbuilding. The above results, together with the entire absence of blisters, show the high grade of product obtained.

It is, of course, somewhat difficult to estimate the probable cost in a properly organized plant from data obtained in working a single machine under experimental conditions; but the indications are, and it is confidently believed that slabs and billets, and probably the finished product, will be produced at a cost not exceeding that of ordinary steel.

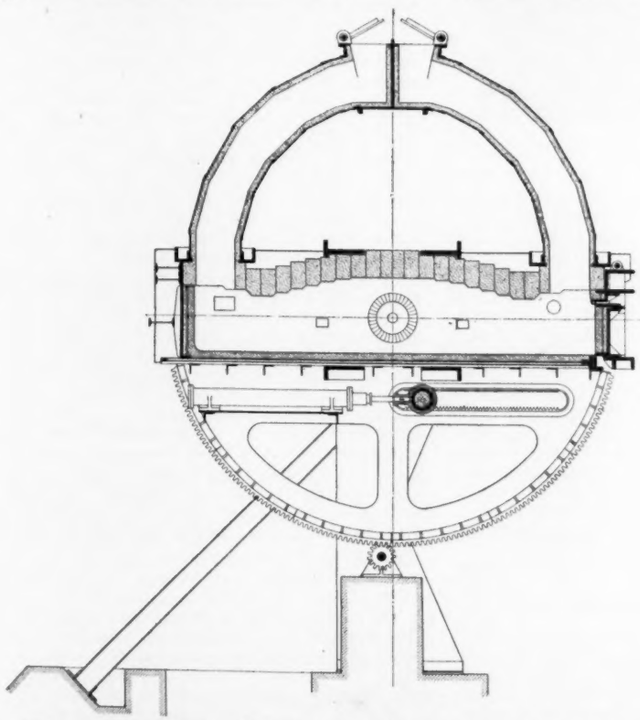


FIG. 3. LONGITUDINAL SECTION OF ROE'S PUDDLING MACHINE.

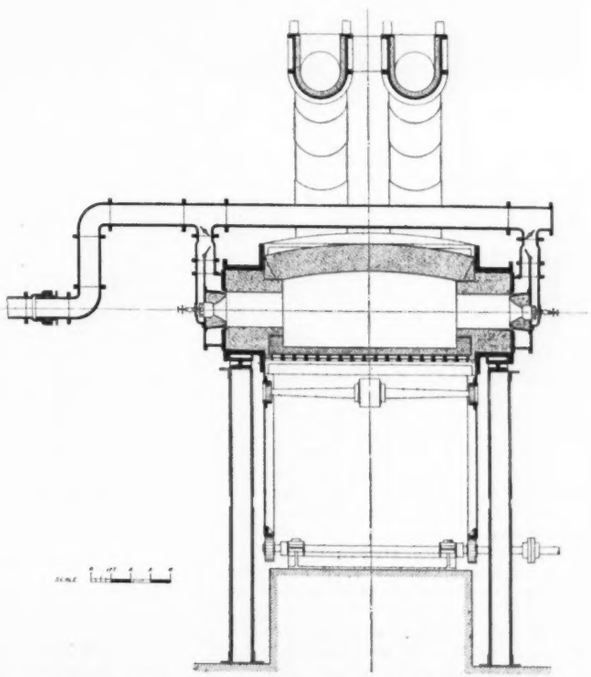


FIG. 4. CROSS-SECTION OF ROE'S PUDDLNG MACHINE.

THE WIGWAM RESERVOIR MASONRY DAM OF THE WATER-WORKS OF WATERBURY, CONN.

By R. A. Cairns,* M. Am. Soc. C. E.

The city of Waterbury is a prosperous manufacturing community in the Naugatuck Valley. Its population was 3,536 in the year 1774, a figure not exceeded until 1840, when it was 3,668. Since that time it has become the center of the brass industry of the United States, and has had almost uninterrupted prosperity. It is said that between

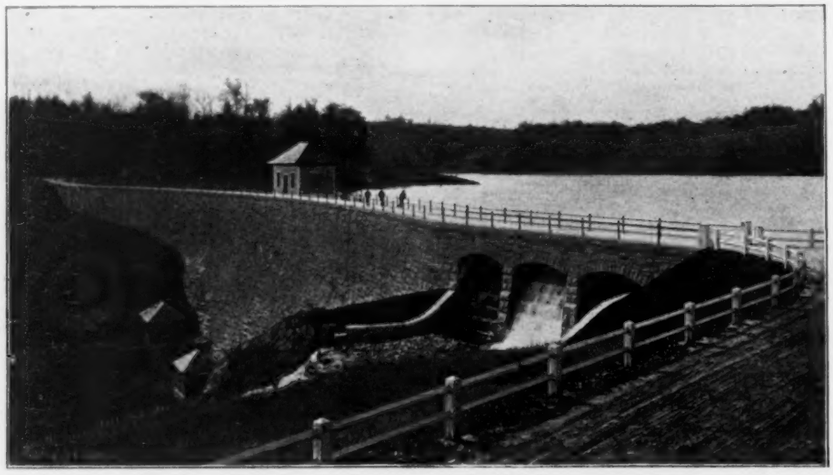


FIG. 1. VIEW OF WIGWAM DAM AND RESERVOIR, FOR THE WATER SUPPLY OF WATERBURY, CONN.

1861 and 1865 the enlistments in the army reached almost one-twelfth of the entire population, a record seldom equalled, and yet the census shows an increase even in that decade from 10,004 to 13,106. In 1880 the census was 20,270; in 1890, 33,202; and in 1900, 51,139. At present the population is estimated at 55,000, and it is expected to reach 74,000 in 1910.

Previous to 1868 the water supply was in private hands, and of limited extent. At that time public works were constructed, giving a gravity supply of excellent water from the hills to the southeast. After some extensions these reservoirs collected the drainage of about one square mile, with a storage capacity supposed to be 180,000,000 gallons. From 1883 to 1893 there was a constant agitation for an increased supply, but owing to irreconcilable differences of opinion as to the best source from which to get it nothing was done except the establishment of a temporary pumping plant, taking water from Mad River. The quality of this water was not all that could be desired. In 1893 a report on the subject was made by the city engineer, who had not previously been consulted, in which he advocated the abandonment of all the plans which had been under discussion, and urged the adoption of new plans on a far greater scale than had before been contemplated. After some opposition on the part of those faint-hearted ones, who could not believe in the figures of future growth offered by the engineer, figures which it is interesting to note have been fully justified by the last census, his suggestions were enthusiastically adopted and construction promptly begun. The work was placed in the hands of a Committee on an Additional Water Supply, consisting of city officials and influential citizens. The plans were all made by the writer, and have been carried out under his supervision.

The territory selected for a gathering ground lies to the northwest of the city, among the Litchfield hills, at a distance of about ten miles. It has an area of 18 sq. miles, drained by the West Branch of the Naugatuck River.

An accurate investigation showed a population of less than 25 persons per square mile of watershed. Probably two-thirds of the region is wooded, farming being carried on to a less extent than was the case fifty years ago. The main stream has an average inclination of about 60 ft. per mile, and flows through a valley having a narrow floor and very steep side hills. Tributaries to the main stream have such inclinations as to make it out of the question to place storage reservoirs on them. Owing to these unfavorable conditions it has been found advisable to limit the provision of storage to such an amount as will insure a safe uniform yield in dry seasons of 600,000 gallons per day per square mile of net land surface, or a total average daily yield of 10,500,000 gallons. After this storage has been developed the ratio of land surface to water surface will be about 3%. On the basis of Sudbury figures this would require storage to the extent of 105,000,000 gallons for each of the 17½ sq. miles of net land surface, or a total of 1,838,000,000 gallons. Owing to the steepness and imperviousness of much of the country, as compared with the Sudbury district, the above amount has been increased to 2,250,000,000 gallons, and it is proposed ultimately to have three reservoirs in the valley, each holding from 700,000,000 to 800,000,000 gallons. It is interesting to note that there is another watershed lying further north which can readily be made tributary to the present system whenever it shall become necessary. This will increase the gathering ground by 27 sq. miles of very sparsely inhabited country. The site selected for the lowest reservoir of the system is at the junction of Fenn Brook with the West Branch. The main stream just below this junction flows through a narrow gorge with a precipitious hillside of outcropping ledges on the north, and a steep slope on the south, having a few feet of earth above the rock. The bottom of the valley is about 80 ft. wide, and its width 75 ft. above the bed of the stream is about 600 ft. At this point a masonry dam was constructed.

In order to secure the desired depth of water it was necessary to construct in what is known as the South Gap an earth dam about 35 ft. high and 600 ft. long. It has a concrete core wall carried down to ledge or very firm gravel and hard pan. The earth slopes are 2 to 1. On the water side the slope was covered with 10 ins. of broken stone and 18 ins. of closely laid stone paving, thoroughly chinked. This paving is exposed to waves from a stretch of water nearly a mile long, in the direction of the prevailing winds. After seven years it shows no disturbance. At the north end of this dam was found an excellent place for an overflow in rock, which was made 170 ft. long. The top of the dam is 9 ft. above the level of the spillway, and 2½ ft. above the crest of the masonry dam.

A general view of the main dam from below is shown by Fig. 1, while Figs. 2 and 3 show a general plan and maximum section, respectively. Fig. 3 also indicates the distribution of mortars used and the progress from year to year. The central portion of the dam was built on a curve, having a radius of 600 ft., and a chord of 391 ft. While this arrangement adds a little to the total amount of masonry, and a good deal to the work of the engineer in charge, it certainly creates such an impression of security in the mind of the public as to be well worth the extra trouble and expense. The ends of the dam, where the depth of water is less than 20 ft., are straight, being extensions of the chord line of the central portion. The flow line adopted is 425 ft., city datum, giving a static head of 280 ft. in the center of the city. A satisfactory condition of ledge was found about 14 ft. below the bed of the brook, with the dip about 30° upstream, rendering percolation under the dam very unlikely. The result is a maximum height of dam of 91 ft., which is believed to be the highest in New England, pending the completion of the Wachusett dam in Massachusetts. Excavation over most of the north shoulder did not exceed an average of 5 ft. in hard gneiss, changing however to sandstone near the northerly end of the dam, which was cut out to a depth of about 10 ft. where the small spillway is located.

On the southerly side of the valley, nearest the bottom, the ledge proved to be so shaly that excavation reached a depth of 30 ft. before the rock became solid enough to be satisfactory, and over the upper part of this end of the dam the rock cuts averaged 8 ft. In the end, however, every part of the dam was founded on ledge of good quality. Great care was taken in preparing the ledge for masonry. Final blasting was done with light charges of black powder, and was followed by very thorough and patient removal of all loose rock by barring and wedging. All seams were bored out by water under pressure and filled with Portland cement grout. Immediately before laying masonry the foundation was made perfectly clean and covered with 2 to 1 Portland cement mortar. The body of the dam is formed of rubble masonry, using local stone from quarries about half a mile distant. The facing of both sides is broken ashlar, averaging 30 ins. in thickness, of a high grade of granite, part of which came from quarries four miles away, and part was brought from Vermont. All facing stone was set normal to the line of pressure. Owing to the depth and narrowness of the valley, and the violent

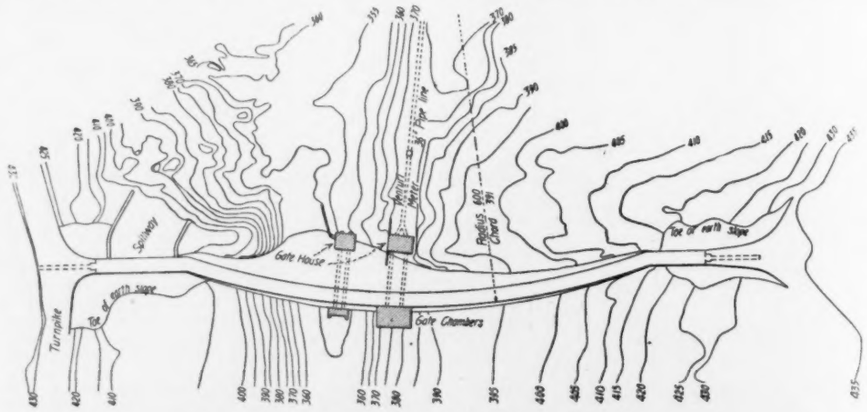


FIG. 2. PLAN OF WIGWAM RESERVOIR DAM.

*City Engineer, Waterbury, Conn.

character of freshets, it was found that temporary works for controlling the stream at all stages would be very expensive. So only a small temporary dam and flume were put in, sufficient to take care of ordinary flows, and when the floods came they were given the right of way. No loss resulted except a few days delay and extra pumping, the floods bringing almost no detritus, and the masonry (below the bed of the stream; see Fig. 3) laid in mortar composed of high grades of Portland cement and sand, 2 to 1, suffered no injury.

When the masonry reached the level of the bed of the stream two lines of 30-in. cast-iron drain pipes were built in, with gates and a gate house at the down-stream toe of the dam.

A gate chamber with two separate compartments was built on the up-stream side of the dam, and provided with inlet pipes and gates at elevations 11 ft. apart. Each compartment has one inlet with its bottom 55 ft. below the flow line, and the other and higher inlets are alternated between

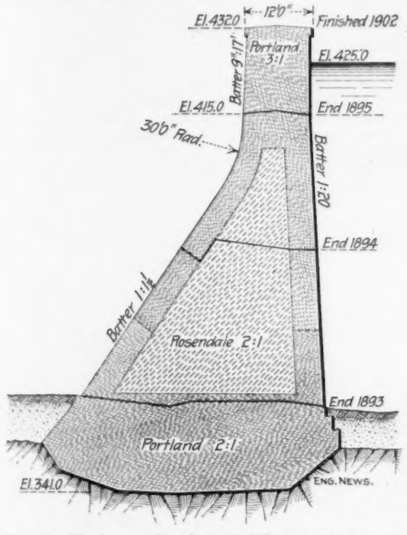


Fig. 3. Maximum Section of Wigwam Reservoir Dam.

the two compartments. Vertical screens 5 ft. wide, composed of copper wire in wood frames, extend from the top to the bottom of each well, and a 30-in. pipe from the bottom of each well leads through the dam to the service gate house, where either or both may be used to supply the 36-in. pipe line to the city. Provision is also made so that either well may be drained out into the old brook channel. Immediately below this gate house is a 36-in. Venturi meter, recording all the water supplied to the pipe line.

Construction was begun in the spring of 1893, and all work done that year was by the day. It included excavation for and construction of that part of the masonry dam below the bed of the brook, as well as much stripping of the basin, and grading portions of the pipe line. In the winter of 1893-4 contracts were let for all work necessary to complete the reservoir to a flow line of 410 ft. city datum, including dams, road diversion and stripping of the basin, and for the completion of the 36-in. pipe line to the city. During 1894 and 1895 these contracts were executed, and a regular supply was furnished in January, 1896. It was decided to postpone further work at the reservoir until more storage should be found necessary, but the rapid increase in consumption, due to the growth of the city and the very dry season of 1899, forbade longer delay, and in the year 1901 and 1902 the dams were built up to their full height as planned. At the same time the additional flowage was thoroughly stripped of top soil and all stumps and roots taken out. It is believed that the basin of this reservoir, which was naturally free from objectionable features, has been stripped and cleaned in an exceptionally thorough manner.

Very careful and thorough work was the rule in all departments, and no expense was spared to secure minute inspection at every stage. Especial emphasis was laid on inspection of masonry in the main dam, and exceptionally competent men were obtained for this purpose.

It is no exaggeration to say that an inspector saw every large stone set in place, and in every instance where there was the least uncertainty as to the perfect bedding of any stone, it was required to be repeatedly lifted and reset until no doubt remained. Spaces between the larger stones were carefully built up with mortar and spalls so as to form the densest possible aggregate, with no stones in contact. Much attention was also paid to thorough bonding in all directions. The utmost cleanliness was insisted upon at all times, stones were washed and scrubbed with wire brushes whenever necessary, and liberal use was made of water under pressure for scouring the wall ahead of the masons, and for preserving a proper degree of moisture in the work at all times. Every precaution was taken to prevent any foreign matter from coming in contact with or being incorporated into the masonry.

The reservoir was first filled to its maximum level in December, 1901, the water rising rapidly as a result of a severe storm. Observations since that time indicate that the work is of excellent character, leakage through the dams being very small. On the down-stream face of the masonry dam the sweating is so inconsiderable that on a clear bright day it practically all evaporates.

The reservoir has an area of 105 acres, and a total capacity of 735,000,000 gallons. The average daily consumption is now 5,500,000 gallons.

The pipe line, of cast iron, traverses a broken rocky country, and for a large part of the distance the construction was very expensive. It was all laid to line and grade. The first five miles from the reservoir, including nearly the entire fall, is all on a descending grade. Throughout the whole ten miles it is equipped with stop gates, blow-offs, air valves, and manholes every two miles, all enclosed in brick gate houses, except in highways. At four points it crosses streams on specially designed steel bridges of the Pratt truss type.

Before being covered it was all given an hydraulic test of at least 150 lbs. per sq. in. In the seven years it has been in use it has required very few repairs, and these have not been chargeable to defective workmanship.

Mr. D. W. Cole was resident engineer on the pipe line, and afterwards had charge of the completion of both dams, and of all other work at the reservoir. There has been expended on this additional water supply to date about $850,000, of which about $500,000 was required for the pipe line, and $350,000 for the dams and other works at the reservoir.

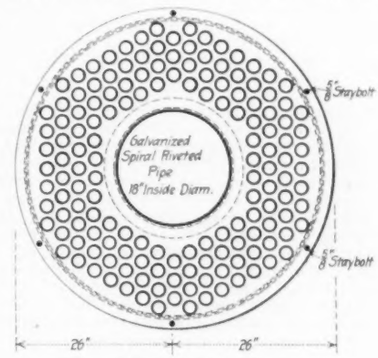
A CONDENSING EXHAUST HEAD.

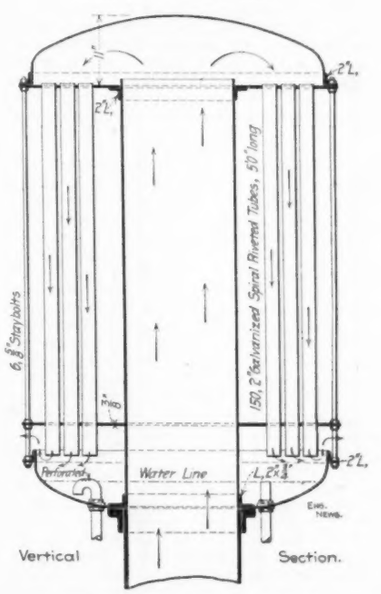
The necessity of providing an effective exhaust head at the outlet of pipes discharging steam into the atmosphere in towns or cities is well understood by engineers. Pipes not fitted with such heads frequently discharge a shower of spray, particularly when the engine is first started, and are likely to subject the proprietor to a suit for damages or an indictment for maintaining a nuisance. A good exhaust head should not only extract from the current of steam all particles of water or oil leaving only a dry cloud of vapor to be dissipated in the air, but should also serve as a muffler, preventing the noise of the exhaust or its pulsations from disturbing people adjacent to it.

The exhaust head here illustrated has been recently put into use on some large installations in New York city, among them the new Ansonia Hotel, the Grand Central Station and the Hudson and Dun buildings, and is reported to give entire satisfaction as a muffler as well as a remover of entrained water from the exhaust.

It will be seen to be really a small air-cooled surface condenser. The exhaust passes up the central pipe, is deflected downward by the vertical dome and passes through a large number of 2-in. pipes to a final exit at the bottom. The particles of water or oil in the flowing steam adhere to the sides of the small vertical tubes, flow down them and drip into the tank below. It will be seen that in the head illustrated these small pipes expose over 300 sq. ft. of surface to the flowing steam. The tank in which the water collects has two pipes from it, one from the surface which discharges the floating oil, the other a siphon drain pipe which discharges clean water, and this may be piped back to the engine room to be used over again.

Where the weight of the exhaust head upon the upper end of the pipe is an objection, the head can be separately supported on the roof or other structure and the exhaust pipe is connected by an elbow and flexible joint so as to deliver steam





A Condensing Exhaust Head.

R. P. Bolton, M. Am. Soc. M. E., Inventor; Thorpe, Platt & Co., Manufacturers.

into the top of the head. This arrangement was adopted at the Ansonia Hotel.

This exhaust head is the invention of Mr. Reginald Pelham Bolton, M. Am. Soc. M. E., and it is being manufactured by Thorpe, Platt & Co., of 97 Cedar St., New York city.

CLOSING A CREVASSE IN A LOUISIANA LEVEE.

The following account of the methods of work adopted in closing a crevasse in a Mississippi River levee at Magnolia, La., is published in the New Orleans "Times-Democrat." The crevasse occurred on Sunday, April 5, and was closed by the following Thursday. The work was described to a reporter of the above named paper by ex-Congressman Wilkinson, who took an active part in the work of closing the crevasse:

Mr. Wilkinson, when asked for some particulars of the Magnolia crevasse work, said that on the arrival of Superintendent Landry, Commissioner Perez, his brother Horace and himself, on a Grand Isle Railroad special at 10 o'clock Sunday morning, with a trainload of material, a cave was found to have taken in all the crown and a slice of the land side of the levee near the upper line of the Magnolia plantation for fully 100 ft. Over this sharp edge the water was flowing about 2 ft. deep and this

narrow edge was rapidly eroding. The railroad embankment ran close to the foot of this levee, with a ditch between this embankment and the levee and another ditch between the embankment and the public road. A narrow space was thus left between the railroad and the river and over this narrow space we found a crib work had been just started before we arrived.

After a hurried consultation between Mr. Warmoth and ourselves, it was decided to continue the cribbing just started, the plantation forces attending to the driving of piles and carrying of sacks, and the railroad forces to the bracing of the cribs against the railroad itself, the staking down of the ties and the furnishing of material. This line, or rather three lines of crib work, about 170 ft. long, was sacked and braced as fast as made, and by sundown or nearly afterwards, the ends had met, although the sacking and bracing were kept on until late in the night, or until nearly daylight. By the time the crib work and sacks had been made to meet, the sharp edge of the levee had eroded to a depth of about 6 ft. We then attempted to strengthen the work by dumping sacks of earth on the river side of the cribs, but these failed to make any show above the water after dumping more than a carload of sacks, and soundings were attempted and no bottom could be found with the longest sticks of scantling on hand. Soundings made two days afterwards at this point by Mr. Goddart, of the United States Engineers' office, and Mr. Belden, of the Grand Island Railroad, showed a depth of 34 ft. It was, therefore, not surprising that the sacks dumped there failed to show above the water.

After the work of Sunday and Sunday night no more piles could be driven in the narrow space between the railroad and the river, because there was no space to put them in and nothing more could be done to strengthen or tighten the frail structure through which streams of water were constantly running, and which seemed likely to cave in the river at any moment. The problem now was to construct a second and larger line that would be long enough not to cave in the river, and strong enough and tight enough to withstand any pressure that might be brought against it, and to finish this before the first line caved in the river, as we knew it ultimately would.

After a careful consultation we decided where, at both ends, to start the second line, which was to be permanent work and which required to be about 420 ft. long. On Monday morning we tore up the railroad tracks on each side of the work and started out in earnest on the construction of the new line of work. There was no way to obtain any earth except by carrying it from a distance on the Grand Isle Railroad cars in sacks, that railroad having a locomotive and cars on each side of the break. In order to use wheelbarrows also, we were compelled to dam off and drain onto neighboring land a sufficient area to secure the earth for wheelbarrow work, although much of this was so wet and mushy that but slow headway could be made with it. There were two divisions of the bins or timber work compartments, into one of which the sacks were carried and into the other the loose dirt was wheeled. The first of these was 6 ft. wide and the second 8 ft. wide. These bins were hastily, but accurately constructed, and were filled and braced from behind the last bin as fast as constructed. The inside line or wall had a continuous low wall of tongued and grooved sheet piling driven 2 ft. in the ground, so as to make as much as possible a water-tight joint at the surface of the ground.

The water running through the cribbing and sacks constructed so hastily on Sunday, and which the close proximity to the cave prevented making any stronger and tighter, was diverted to the lower end of our second line and made to pass over a hard road, the surface of which did not quickly erode. After the timber work was nearly completed and the partitions partially filled, a series of cribs were constructed on the lower end, where the number of bins was increased and the work made wider. Into these bins sacks were thrown so as to shut off gradually the flow of water that came through the temporary work, and raise it against the permanent work so as to bring the pressure gradually against it. In this way the pressure was increased as the height of water was brought up inch by inch. The sacks placed in these cribs were placed in terraces. Those in the outside crib highest, those in the next not so high, and those in the last still lower, the water therefore falling from the last terrace with much lessened height and force. This work was nearly completed on the evening of the third day and during all the days and nights from the first there was the constant dread that the temporary barrier through which the water ran in constant streams would give way before the permanent line could be completed. The first work stood, however, until the night of the third day with little damage except from the increasing streams which darted over the sack terraces in the lower ends with the sounds intensified at night until the roar appeared as if a hundred torrents thundered down the mountain side together. On the night of the third day the outside work started to go in the river, and first one pile and then another were undermined and projected in the air and then on the water. At 5 o'clock in the morning, when my brother Horace was on duty, the caving increased, and on my arrival on the scene shortly afterwards we concluded to try to hold out the water no longer from exerting its full pressure against the new work, as it was evident from the dull sounds of earth sacks dropping in the river and uprooted piles, tie beams and braces racing wildly in the eddies that the destruction of the first work by caving was a matter of minutes, not hours, and so, as the roar of the water over the sacked terraces in the ends grew louder the final sacking was started and completed. With many an anxious inspection of braces and back supports to see if the maximum pressure was safely withstood and reinforcement speedily made where any weakness showed, and then with hasty driving of the sheet piling behind the space that had been left partially open at the lower end, at 9 o'clock on Thursday morning the Magnolia crevasse was practically, and I hope, permanently closed.

NOTES FROM THE ENGINEERING SCHOOLS.

CORNELL UNIVERSITY.—Prof. H. Wade Hibbard recently gave an address before the students of Sibley College on "Engineering Periodicals and the Card Index." Referring to the American engineering press, he said!

Among the most valuable members of the engineering profession to-day are the moving spirits of the engineering press. The American papers, representing special branches of the profession, far surpass in numbers and variety and excellence the like papers of the old world. Their general use proves that they have a most important place. With these may be grouped the published transactions of the many engineering societies and clubs. Unthinkingly or deliberately to neglect forming acquaintance with so great a source of engineering knowledge is not fitting for the student who has his own future to make in a country where ruts and old fashions are only for the failures.

The address has been printed in pamphlet form and copies can probably be obtained by addressing Prof. Hibbard at Ithaca, N. Y.

UNIVERSITY OF WISCONSIN.—The Summer School for Artisans, under the direction of the College of Engineering, will give courses in shop and laboratory practice from July 6 to Aug. 14. One of the aims of this school is to supplement the work done by the numerous correspondence schools of engineering. No examinations need be passed to take any of the courses, and the total cost to the student, including living expenses, need not exceed $50. There are six courses offered: (1) Heat, Steam and Gas Engines; (2) Applied Electricity; (3) Machine Design; (4) Materials of Construction; (5) Shopwork; (6) Surveying. This work is in every way to be commended, and should enable the "practical man" to gain a still more practical knowledge of his work, rounding out a knowledge that he may have gained from reading Prof. F. E. Turneaure, Madison, Wisconsin, has charge of this Summer School.

THE CORINTH SHIP CANAL is a failure commercially, according to a report by U. S. Consul Frank W. Jackson, of Patros. The canal was completed in 1893, after the expenditure of about $11,000,000, and after a series of financial misfortunes on the part of the company organized to build it. It shortens the distance between ports in the Adriatic Sea and ports in the Piraeus, about 130 miles, yet it is practically deserted by vessels, which prefer the long sail around the Grecian peninsula to passage through the canal. The reason, as given by Consul Jackson, is the danger of navigating the canal on account of the winds and tidal currents. The canal is cut for part of its length through a rocky ridge and the walls on either side rise to a height of 260 ft. with a width at the bottom of 69 ft. Says Consul Jackson:

The winds which render the open gulf a raging sea do not subside at the approach to the water way. The canal is like a huge air shaft, and the mighty currents of air which rush from one gulf to the other are not calculated to encourage the mariner to run his ship between precipitous walls 260 ft. high and separated by only 80 ft. of sea. A second obstacle takes the form of a reversing current, due to the striking variation in the tides of the two gulfs.

The canal entrances are now protected only by small breakwaters, and the navigation at the entrance of the canal is very difficult. It is proposed to build large harbors at each end in the hope that vessels may thus be induced to use the canal.

THE NEW YORK STATE 8-HOUR LAW has been declared void by the Court of Appeals in rendering a decision in the case of People vs. The Orange County Road Construction Co. The Court of Appeals had before declared the "Prevailing Rate of Wages Law" and the "Cur-Stone Law" void; now the last labor restriction placed upon contractors doing public work in New York State appears to have been removed. It is held that the State and municipalities within the State cannot be made by law to restrict the hours of labor unless such restriction is explicitly for the purpose of preserving the health or morality of the workers. It is well that this pernicious law has finally been declared void, but it has done much mischief now irreparable. Since it was so drawn as to go into effect immediately upon receiving the Governor's signature, it virtually robbed many contractors who were in the midst of work on contracts which they had taken prior to the passage of the law. Reducing the working hours from ten to eight added 25% to the labor cost of these contracts.

THE WORKING OF THE LORAIN surface-contact system of electric traction on the Wolverhampton, England, line has been reported on by the electrical engineer for the borough, Mr. C. E. C. Shawfield, whose report is reprinted in the London "Electrician." The line is 11 miles long, and in 13 months the traffic aggregated 43,486 car-miles. The contract for the construction made a condition of acceptance that the system must prove a "commercial success" after a year's trial. This question is treated under five heads. Under "safety to human beings and animals" the engineer reports on cases of contact studs found to be "live," and on the accidents therefrom; he concludes that in the matter of safety "the Lorain system may be considered to fulfil the conditions of the contract." As to reliability, he concludes that "there is little to choose between the Lorain system and the overhead system." In the matter of current consumption, he finds that the Lorain system consumes 22% more current per car-mile than an overhead system (1.4 against 1.15 KW.-hours); other items of operating cost are not affected either way by the use of this system. The cost of maintenance and inspection for the special equipment of cars and track, is greater with the Lorain system, being about double that for the overhead system (0.8 against 0.4d. per car-mile). On the whole, it is concluded that the system fulfils the contract requirement as to being a "commercial success," the recommendation being made, however, that the contractor be required to replace the contact plates by an improved form.

A NEW MAP OF ALASKA has just been completed by the U. S. Geological Survey. The scale is 40 miles to the inch and contours of 1,000 ft. intervals are shown. This is the first contour map of Alaska and, despite the large contour interval, should prove of great value. The survey of Seward Peninsula is to be completed this summer, and two parties will be organized for surveys in the Yukon gold district. One party, under Mr. T. G. Gerdine, will make a topographic survey from the Forty-mile region westward to the Tanana River. The rich gold fields of the Tanana, toward which such a rush is taking place, will be mapped, and the geology of the region will be investigated. The Kayak Island and Controller Bay coal and oil fields will be examined by Mr. Frank C. Schrader, who will spend two months in that region.

WIND PRESSURES recorded at Greenwich Observatory during a number of years are given by Mr. W. A. Burgess in a letter to the London "Standard," a portion of which is quoted in "The Engineer" for April 24, 1903. We abstract the following figures from the last-named paper:

With a mean temperature of 44.92° and 45.95°, or 5.42° and 4.23°, above the average of 50 years at Greenwich Observatory, the gales and storms of February and March, 1903, from the west and south, have probably had few parallels in the last half century. At Greenwich Observatory the anemometer showed a mean maximum pressure of 22.57 lbs. to the sq. ft. for the week between Feb. 21 and 27, 37 lbs. and 33.2 lbs. being registered on the 24th and 27th respectively. The mean maximum force between Feb. 19 and March 2 was 18.5 lbs. per sq. ft. for the 12 days. In the fortnight from March 17 to 30, the mean maximum pressure was 12.8 lbs.; for February, 9.7 lbs.; for March, 8.84 lbs., or 9.27 lbs. as a daily mean for the whole two months. During the last decade the maximum force of 37 lbs. per sq. ft. of Feb. 24, 1903, was exactly equaled to the great storm, from the south, of Dec. 12, 1893. The nearest approach to the other February readings were in February, 1899, when, in the week between Feb. 8 and 14, the mean maximum was 17.53 lbs. per sq. ft.—maximum 33.4 lbs., on the 13th—while from Jan. 16 to 22, 16.47 lbs.; and from Jan. 12 to 23, 1890, a mean maximum of 15.45 lbs. was registered, including 32 lbs. on Jan. 12, and 28 lbs. on the 21st. In February, 1894, there was a mean maximum force from west-southwest of 17.36 lbs. for the week between the 6th and 12th, a force of 35 lbs. being read—south-west—on Feb. 11. In the memorable equinoctial gale of March 24, 1895, a pressure of 36 lbs. was read at Greenwich, and enormous havoc was done among forest trees over a great part of the country. On Nov. 14, 1894, a force of 29.5 lbs. was read, 30 lbs. to the sq. ft. on Dec. 22, and 28 lbs. on the 29th. There occurred on Nov. 29, 1897, the highest and most destructive tide upon the east coast of England since 1845, accompanied by a northwesterly gale of 25.3 lbs. and 26 lbs. force at Greenwich on Nov. 28 and 29. On Dec. 27, 1898, 29.8 lbs. was read; on Dec. 28, 1900, 27.5 lbs., and on Jan. 27, 1901, a maximum force of 34.4 lbs.

A LARGE SINGLE-CYLINDER GAS ENGINE has been built in England by Mather & Platt, of Manchester. The engine is peculiar in being double-acting and working on the two-stroke cycle; its capacity is 700 HP. continuously. Direct-coupled to the engine is a 500-KW. direct-current 220-volt dynamo, having 12 field poles and an armature weighing 15 tons. The engine is to run on producer gas. The current is to be used for electrolytic work, where constant running is highly important.

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